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LAND USE IN OHIO: TRENDS, PROSPECTS AND EVALUATION

DISSERTATION

Presented in Partial Fulfillment of the Requirements for the Degree Doctor of Philosophy in the Graduate School of The Ohio State University

By

ROBERT MOFFETT REESER, B.S., M.S.

The Ohio State University
1960

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CHAPTER I

INTRODUCTION

Now we are at a crossroads. At this moment in history, when our population is growing, the demand for many products of fields and forests mounts, and the face of the land is changing, we can choose, perhaps for the last time, what we are to do with our land, our country.

In 1960, Ohio has been settled to some extent by white men for 175 years and has been a state for 157 years. During this period she has, at one time or another, achieved leadership in various aspects of agriculture, steel manufacture, the rubber industry and other industries. Ohio is called the mother of states, the home of presidents, the birthplace of light and flight, and the home of colleges.

In 1960 Ohio has achieved a population of nearly ten million persons and a volume of industrial output exceeded by no state with comparable population or area. In value of agricultural products, Ohio ranks among the first ten states, with a higher output in proportion to state area than all but three of the leaders.

These are achievements to which the citizens of Ohio can and do point with pride. But there are certain other attributes of the past and present development of Ohio which are not sources of pride.

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While the achievements of Ohio in both past and present have been
inextricably linked with the resources—the land—of Ohio and the use
to which these resources have been put, the way these resources have
been used have sometimes returned benefits to a few at the expense of
society, or immediate benefits at the expense of trouble or loss later
on. In some cases, it has been necessary to undo the work of a
previous generation, to correct for the short-sightedness or self-
ishness of the forebears.

The Problem

Currently we, as a society, are facing a dilemma in land use,
involved a choice between unguided, laissez-faire use of land and the
utilization of more social controls on land resource allocation. In a
land market in which there are still relatively few restrictions by
society on the use to which most nonurbanized land may be put, the land
goes to that use which bids highest. Yet this use not infrequently
prejudices the welfare of society.

Rapid increases in population resulting from both natural increase
and in-migration have led to a veritable overflowing of our cities.
High levels of income and prosperity have made possible building of
many new homes. Availability of rapid and dependable individual trans-
portation via automobiles has led to an exodus from the cities to the
suburbs and the exurbs. Housing developments have spread in irregular
ripples or sprung up mushroom-like around the cities. Land needs for
recreation, schools and other service uses have followed. Shopping
centers, industrial and commercial developments, drive-in theatres and
other users of land in the urban complex have superseded crops and livestock as inhabitants of rural areas. To permit quick communication between these outlying nerve centers of society, even wider and straighter roads have been built. These arteries of communication have stimulated developments not only at their termini but also along their edges. Ribbon developments have, by their growth alongside the highways, reduced or eliminated the scenic benefits of the highways and at the same time interfered with the primary purpose of these roads, rapid transportation. More roads have been necessitated, expressways and turnpikes at this stage, with involutions covering acres at intersections. Water problems have been compounded relative to both disposal and supply. Flood control requires dams, levees and impoundment areas, while reservoirs are needed for the accumulation and storage of the additional water requirements of growing cities.

Each of these developments has required land. In a great many cases, the land desired and taken by industry, commerce and residential development has been the best agricultural land. Rarely has agricultural use been able to compete successfully with factories, shopping centers, truck stops or ranch-type houses. Where uses with more immediate benefits have sought control of land, they have been signally successful.

Part of the reason for agriculture's inability to bid competitively for land desired for other uses has been the depressed economic condition of farming. Overproduction of agricultural products relative to effective demand has resulted in lowered prices. At these prices, the returns to resources are depressed, and the price of farm land
justified by anticipated returns is low. However, even if agriculture were healthy rather than depressed, more intensive uses for land would normally supersede farming where competition exists for the services of the land resource.

The urban complex of land uses which has competed with agricultural uses comprises, in the main, uses which are virtually irrevocable. True, some of our pioneer settlements have reverted to cornfield or forest, but steel and concrete make highways, building sites and other highly developed tracts practically incapable of recession to any lower use. Housing developments or parking lots could, of course, be restored to agricultural productivity if the need were sufficient to justify the cost. The physical possibility of such change is not denied.

Some of the features of our landscape are aesthetically undesirable. Billboards, dumps and auto graveyards are examples. Yet whatever the qualitative effect may be, the quantitative requirements of uses such as these are small in the aggregate. Perhaps they can be disregarded because of their quantitative unimportance.

But some of the ways in which land is used make major changes in the whole land use pattern. These cannot be disregarded. The encroachment of cities, highways, industries, and certain recreational uses of land reaches a level at which there is both quantitative and qualitative basis for real concern.

At the present time, agriculture is plagued by surpluses, and disposal or reduction of these surpluses receives the attention of many who consider this to be the dominant agricultural problem. Withdrawal
of farm land into urban or other nonfarm uses is one way in which agricultural production can be reduced. Thus, a partial solution to the immediate problem may be provided by the same processes which, over a longer time span, generate another problem. It is to the long-time outlook and the eventual problem of sufficiency of land for agriculture that this study is oriented.

At the same time that the number of consumers grows and the need for food increases, the increase in nonfarm uses of land is under-cutting the area base of agriculture from which the food needs of the increasing population must eventually be met. Recognizing the need for increases in some non-agricultural uses of land, more of these needs could be met from land of lower agricultural potential. That population may outrun technology appears to be more than a pedantic possibility. The man-land ratio may drop below the level which technology can offset, with a resulting decrease in the level of living and quality of diet. Viewed with a perspective or planning horizon of a few generations, adequacy of land for agricultural appears to be a real threat.

Objectives of the Study

It is the purpose of this study to investigate certain aspects of the land use pattern in Ohio, with the ultimate objective of evaluating both the end product and the method of allocation of land use.

A more complete statement of the objectives of this study necessitates specifying four steps:

1. Development of an understanding and an analytical framework of the changes in land use in Ohio over time;
2. Determination of the probable characteristics of the land use pattern corresponding to specified time periods in the future, utilizing the framework developed under 1;

3. Formulation of a standard or criterion against which a given land use pattern can be measured or evaluated relative to its fulfillment of the anticipated needs of society;

4. Evaluation of the mechanism of allocation of land use by comparison of the expected end result of this mechanism (projections) with ideal patterns (criteria). Evaluation is necessarily with reference to certain objectives or goals imputed to society.

These four steps are seen as prerequisite to policy recommendations bearing on changes in land use or in methods of allocation of land use which are found to be desirable in order better to meet the needs of society. 2

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2These objectives are closely related to and based upon a research assignment from the Ohio Agricultural Experiment Station with which the writer has been associated. The project statement of project State 236 says in part:

Purpose: to formulate a long-range land use plan (for Ohio) that (1) would indicate the highest and best uses of the land surface of the state in light of present day knowledge and the expected future demand for the products and services of land, and (2) would improve the productive capacity of some and maintain the productivity of all.

("Formulation of a Long-Range Land Use Pattern for Ohio," Project No. State 236, quoted from "What We Do," a mimeographed report of the Department of Agricultural Economics and Rural Sociology, The Ohio State University and Ohio Agricultural Experiment Station, September, 1958, p. 49).
Preview of Methodology

One's expectations for the future are ordinarily based upon one's knowledge of the past. Expectations with respect to future land use patterns are no exception to this general rule. Efforts to determine what lies ahead for land use in Ohio will, therefore, commence with a study of the trends in land use in this state over the past half century or more. Attempts will be made to explain these trends in terms of physical relationships, economic concepts and principles, and whatever other facts seem to be pertinent. Major trends will be analyzed and projections fitted to the land use data to aid in visualizing relationships and quantifying forecasts. Those factors which helped to explain past trends and changes will be utilized to modify mathematical projections, and anticipated patterns of land use for specified dates in the future will be developed, not as firm forecasts but as indications of the general direction in which economic, physical and social forces are moving. Other projections of land use, and statistical information from a variety of sources, will be used to supplement and to cross-check the trends and projections in land use.

A standard of criterion against which a given land use pattern can be measured will be developed. Since many categories of need for land appear to be proportional to population, projection of the population of Ohio is a first step. Per capita rates of land use will be established on the basis of current use or on some authoritative "desirable" use and applied to the expected population, to indicate the required or desirable acreage.
The resulting criterion permits an objective weighing of the projected land use patterns and an impartial consideration of its merits and shortcomings. The effects of changes in the land use pattern can also be appraised, and if alternatives are posed the most desirable can be selected. The logical next step of formulating the policies which will yield these alternatives is left to subsequent research, but general policy recommendations may be drawn from the divergence of projected from recommended land use patterns.

Implicit in the objectives are several assumptions and components which are subject to various interpretations. Some of the more important of these will be briefly discussed as they relate to this study.

A long-range land use plan is one which is oriented to the needs of the future, rather than to present or short-run needs. Comparison of needs at two points in time necessitates use of compound interest or discount schedules; the appropriate rate of interest or discount for society will be different from that for the individual. However, a meaningful evaluation of land use can be made by comparing projected to ideal allocation for the same time period, thereby avoiding the need for discounting.

Highest and best use of land resources is their use "in such a manner as to provide an optimum return to their operators or to society." The returns to land need not, however, be measured solely

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in terms of monetary return. Society is becoming increasingly aware of aesthetic and intangible values in the use of land. Such features as preservation of scenic or historic spots, incorporation of open spaces and amenities in urban development, non-use of biological or mineral resources in the name of conservation for future generations, may very well be included in a plan without contradicting the concept of highest and best use.

A further point is that uncertainty exists as to what is or will be highest and best use. Imperfect knowledge of which alternative use will provide optimum returns in the present necessitates planning "in the dark" with some adjustments being made to minimize risk. Planning for future use is infinitely more risky, but it is necessary that decisions be made. In this study, a conservative bias resulting in plans that are "on the safe side" probably can be detected.

The land use plan formulated should be capable of reduction to physical terms. A statement, e.g. that urban areas will increase, has little meaning unless accompanied by a percentage of some specified base or by a quantified estimate of acreage of increase. Recommendations contained in the land use plan must be specific with respect to acreage, and insofar as possible with respect to location.

Estimates projections or guesses of land needs for various purposes assume an almost infinite variety of combinations; therefore, some basis for choice among the alternatives is important. The formulation of a criterion against which these estimates can be measured, and an objective method for such measurement, are areas of need to the fulfillment of which this study particularly aspires.
Certain other assumptions necessary in development of subordinate points will be specified at appropriate times.

**Related Research**

It is said that there is nothing new under the sun. While such a statement should not dissuade a researcher from seeking what may be to him new and unfamiliar, it may increase his awareness that other seekers have sought before him, and that most of the paths he blazes through the wilderness have already been blazed by someone else.

The current study is pursued with the awareness that many other trails have been blazed. Some aspect of inventory, analysis, comparison or recommendation of change in land use has received the attention of researchers almost continually for nearly three decades. It is not feasible to review all of the research related to this study, but a rather restricted sample of work related in concept or purpose is briefly discussed.

The National Resources Board was created in June, 1934 "to prepare and present to the President [of the United States] a program and plan of procedure dealing with the physical, social, governmental and economic aspects of public policies for the development and use of land, water and other natural resources." ⁴ This assignment led to a broadly inclusive and highly detailed study⁵ in the mid-30's considering such

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factors as population, industrial conditions, export policies, soil depletion and conservation, trends in consumption, production efficiency, land reclamation,—in short, just about every factor which could conceivably influence land requirements or the supply of land. Closely related to this study was the delimiting of land-use problem areas, and recommending of the means for effecting the desired adjustments in each area. Also related was the development of recommendations of cropping patterns and agronomic techniques which would achieve control of erosion and soil depletion.

This work was supplemented by the Mt. Weather Agreement of 1938, under which the Department of Agriculture and the state land grant colleges cooperatively undertook programs to bring about improved agricultural land use. This stimulus was discontinued in 1942 but comparable stimuli have replaced it. Work has continued

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6 Sitterley, et. al., Ohio State University Mimeograph Bulletin No. 79.

7 Committee on Regional Agricultural Adjustments, "A Basis for Regional Agricultural Adjustments in Ohio," Unnumbered mimeograph (Columbus: Agricultural Extension Service, 1935); also J. H. Sitterley and J. I. Falconer, "Better Land Utilization for Ohio," Rural Economics Mimeograph Bulletin No. 108. (Columbus: The Ohio State University, 1938).

intermittently to the present time, under both public and private sponsorship.

Some emphasis has been placed on agricultural land needs and resources by publications of the Department of Agriculture. Description of the current land use picture is an essential part of these, but trends in past use and expected future needs for agricultural land are also discussed. An example of this type of publication is subtitled, "An Inventory of the Land Use for Agriculture, with Special Reference to Cropland, Pasture, and Grazing Land Potentials." A less comprehensive but updated version of this proposes to give "a general analysis of the land use situation . . . as of 1954."

Another example which projects past trends to indicate future requirements is the Report of the Materials Policy Commission.

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9 Illustrative of public sponsorship is the following: State Committee on Production Adjustments in Ohio Agriculture, "A Postwar Crop and Livestock Pattern for Ohio Under Conditions of Full Employment," unnumbered mimeograph bulletin (Columbus: Ohio Agricultural Experiment Station, 1944).

10 Illustrative of work done under private sponsorship: The Center for Agricultural and Economic Adjustment at Iowa State University, operating under sponsorship of the Ford Foundation, held a seminar in May, 1960 in "Dynamics of Land Use: Needed Adjustment."


Projected need for agricultural land is influenced by trends in per capita disposable income, food consumption, exports and imports and productivity; these trends and expected shifts in land use influence the price and income level forecast for farmers.

Even more recent work of this nature is reported by Barton and Daly and the work is continuing at the present time.

A brief but well-balanced discussion of Land Resource Requirements is to be found in the chapter by that name in the recent textbook by Raleigh Barlowe. Aggregating and projecting the land requirements for the nation, Barlowe's presentation considers various uses and factors in these uses including the promise of technology, and concludes with this statement:

Man must plan for the future in terms of his available resources. In this process, he must recognize the need for maintaining and conserving his present resource base. Much as he might wish it, he cannot depend upon technology to come to his aid if he dissipates and wastes his resource heritage.

If research in land use is to fulfill its destiny, it must produce recommendations on current problems. Generally speaking recommendations are more readily forthcoming when small rather than large areas are studied. For example, the studies cited earlier which considered all land uses for the entire country give only broad generalized

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15 Barlowe, Ch. 4.

16 Ibid., p. 110.
recommendations. By contrast, a study of land use in northern Minnesota\textsuperscript{17} appraises the resources, their returns and the consequences for society under alternative uses, and concludes with specific recommendations regarding government acquisition of land, reforestation, relocation of settlers, etc. Similarly, local studies of land use are quite specific with respect to recommendations of zoning for industry, recreation or residential use.\textsuperscript{18}

The references cited are evidence that the problems of land use have received considerable attention in this country in the last quarter century. In other parts of the world, where land is in relatively short supply, the impact of adjustments in land use is greater. The experience and point of view of British society which has long faced the problem is presented by Wibberley in \textit{Agriculture and Urban Growth}.\textsuperscript{19} Land economics is utilized to the fullest in decision making by British society relative to the competition for rural land. The concept of opportunity cost for similar services of land is the basis for strong recommendations as to use of specific tracts of land.

\textsuperscript{17}Oscar B. Jesness and Reynolds I. Nowell, \textit{A Program for Land Use in Northern Minnesota} (St. Paul: University of Minnesota Press, 1935).

\textsuperscript{18}One such local study may be cited as an example: Regional Planning Commission Staff, "Land for Industry" (Cleveland: Regional Planning Commission, 1955).

\textsuperscript{19}Gerald P. Wibberley, \textit{Agriculture and Urban Growth} (London: Michael Joseph, 1959).
CHAPTER II
THE MATRIX OF LAND USE

The Threefold Framework of Land Use

The use of land resources takes place within the framework of three sets of factors or influences. These factors—the physical and biological, the economic and the institutional—cannot be separated in actual practice, although individual consideration of each group is useful for analytical purposes.

The uses of land resources in Ohio are subject to the influence of this threefold framework, no less than uses of land located elsewhere although the specific factors have somewhat different effects.

Ohio's past and present importance as an agricultural and industrial state has been and still is dependent upon the physical characteristics of the land. Expectations for future development are similarly related to productivity of soils, climate, topography, location of rivers and lakes, existence of mineral resources and other factors of a strictly physical nature.

Economics, as the science of allocation of resources, plays a major role in the use of land. Land is one of the factors of production. Control of land as a resource is a prerequisite to production in agriculture and also in other industries; the income expected to accrue to land is the justification for the price of this resource in the market. Land is also desired as a consumers' good; the possession of land
directly satisfies human wants. Therefore, land is doubly important from an economic standpoint. The use of land in the attempt to maximize the satisfactions of the individual and of society results in various combinations of land with other resources. This intensity or extensiveness of the resulting land use may maximize certain goals or objectives while reducing the potential achievement of other goals or objectives. Considerable importance attaches to the point of who makes the decision, and whose goals are to be maximized.

The economic machinery by which the use of land resources has been allocated in this county, both historically and in the present, has been the market mechanism. Characterized by the relative absence of controls, this mechanism is commonly and correctly referred to as a "laissez-faire" system of allocation. Under this system, the owner of rights to land may dispose of these rights to whomever he chooses and for whatever remuneration he is able to command.

This market mechanism itself is one of the institutions which make up the third set of influences on land utilization. An institution, as used in this context, is a widespread or commonly accepted habit or pattern of behavior. The customs and traditions, the taboos and compulsions of a society are all institutions. Since tradition or other social compulsions may cause a person to act in a way contraindicated by economic analysis, these institutions cannot be ignored. Examples of institutions with important effects on land utilization in Ohio are the institutions of private ownership of property, the inheritance of property, the use of animal products in the diet, and the family unit in society.
These three groups of factors are not uniformly applicable to all land. As shown schematically in Figure 1, each framework has a sphere of influence, part of which is also affected by other factors. For example, a part of the physical extent of land is influenced neither by economics nor by human behavioral patterns. Antarctica, deserts and land of Capability Class VIII exemplify this situation. Some theoretical economics has no counterpart in real life and so lies outside of the physical sphere. Some institutions in society are related only remotely if at all to physical and economic factors. Each of these frameworks, however, imposes restrictions on land use, both directly and through its interplay with other factors. The use of land for any purpose then is influenced by all of these frameworks, and analysis must likewise consider the threefold framework of land use.

Figure 1. The Threefold Framework of Land Use
Economic Theory Applicable to Land Use

The theory of economics which is applicable to the allocation of land resources may be variously interpreted as (1) those theories and concepts which are applicable only to land, (2) the whole body of economic theory, or (3) something intermediate between these two extremes.

Economics is commonly defined as the study of the allocation of scarce means among alternative ends. The factors of production—land, capital, labor and management—constitute the scarce means. Economics, therefore, is the study of the allocation of land and other scarce factors of production among alternative uses. Thus, all economic theory is applicable to land. However, it is clearly beyond the scope of this work to include all of the theories and refinements of theories which comprise the science of economics.

On the other hand, it is not possible to find economic theories which are properly a part of the parent discipline of economics which are applicable to land but not to other resources.

The intermediate position is thus mandatory. It appears to be a matter of individual choice how much of the field one includes, for an economic analysis using one principle explicitly may involve several others implicitly. It is the intent of this section to introduce only those theories and concepts which are used explicitly and deliberately in the subsequent analysis.
Supply and Demand for Land

Supply and demand necessarily operate in close conjunction with each other; their interaction determines both the quantity bought and sold and the price at which the transaction takes place, under free market conditions.

The interaction of supply and demand can be portrayed by a diagram such as Figure 2. In the model which is represented by this diagram, the line DD represents a schedule of the quantities of a product which would be purchased at a given time and place at each of a series of decreasing prices. Similarly, SS represents the schedule of quantities which would be offered for sale at the same time and place at each of a series of increasing prices. The intersection of these supply and demand schedules represents the equilibrium at price P, since the quantity Q offered by sellers is equal at this point to the quantity which buyers are willing to purchase. Equilibrium cannot occur at a higher price P', for here some buyers would no longer be interested and some would buy a smaller quantity, and the willingness of sellers to supply more (Q') would go for naught. Conversely, at a lower price P" more would be bought if available, but the sellers would be willing to sell only a lesser amount (Q").

The foregoing analysis of supply and demand has utilized the conventional equilibrium analysis, which is applicable to land insofar as land is a consumers' good or a "product" to be bought and sold. Equilibrium analysis of the primary role of land as a resource or factor of production requires different terminology to make the diagrammatic analysis meaningful.
In considering the interaction of supply and demand to determine land use, let SS (Figure 2) represent the supply of land which is offered for use in the production of a given commodity. Other resources will be combined with some quantity (area) of land in the production process, and the demand for the resulting product is represented by DD. The intersection indicates that at price P for the commodity produced, Q area of land will be utilized. Equilibrium cannot occur at a higher price P' although Q' land is available, because the demand for the product is insufficient to justify use of the resource. At a lower price P" more of the product could be sold, but at this price only Q" amount of land is available for production.

**Allocation Between Competing Uses**

Choice between two competing uses for the same tract or quality of land is based on supply and demand curves for the same land and the
products of its alternative uses (Figure 3). At the existing price $P$ for the commodities produced, demand exists for the production derived from $Q$ area of land. If a shift in demand to $D'D'$ results in the price of commodity 1 increasing to $P'$, the land devoted to its production will increase to $Q'$. This increment of land in use 1 will leave less available for use 2, resulting in a new supply curve $S'S'$ for land in use 2, reflecting the reduction in available land. In order to evoke continued production of an undiminished quantity of commodity 2 using $Q$ land, price would have to rise to $P'''$. However, continuation of the same demand schedule $DD$ will call for progressively less of commodity 2 as its price increases, so that $Q'$ land will be used and commodity 2 will sell for price $P''$.

Figure 3. Interaction of Supply and Demand in Allocation of Land between Competing Uses
Actual market conditions tend to follow these equilibrium models, within limits imposed by incomplete knowledge, immobility and other institutional factors. Variations from this model result from differences in elasticity of both supply and demand. The concept of elasticity of supply and demand as such is not essential to subsequent analysis in this study and so will not be developed.

"Supply" and "demand," as the terms are used in this study, are more closely akin to popular concepts of "quantity of resources available for use" and "amounts of a commodity people are willing to buy" than to the concept necessitated by rigorous analysis which sees supply and demand as an instantaneous cross section of potential sales or purchases at all possible prices.

Demand for Land and Opportunity Cost

Land is a factor of production. The demand for land is not restricted to this aspect, however, for land is also desired as a consumer's good. In many cases, the market demand is influenced by both aspects, as is related by Barlowe in this passage:

People often compete for the ownership of particular tracts of land, such as building lots or farms. But except for possible sentimental attachments, they usually are interested in the productive potential of the land or in its location, scenery, or other advantages rather than in the land itself. Most of us want land resources because they supply our needs for food and housing and because they open the way for the realization of various human satisfactions.1

1Barlowe, p. 19.
These two sources of demand may be competitive, as where farm land is desired for urban development, or they may be complementary, as in the case of a farm which provides an attractive residence and recreation site and at the same time provides employment in agricultural production.

In view of the limited physical supply of land and the increase in population, eventual increase in the demand for land appears to be inevitable. Increased input of other factors of production must ultimately encounter diminishing marginal returns. At some point, the increments of labor or capital applied to a given unit of land will elicit barely enough output to pay their cost. Further increases in input would be uneconomic because the cost of the input factors would exceed the value of the product. The maximum physical production of agricultural and other products is great but economic ceilings on production are normally encountered far short of the maximum output. Assuming that demand for the products of land will continue to expand, demand for land itself must also increase.

As the demand for land increases, sharper competition among prospective buyers results in price increases. The amount of increase is influenced by the substitutability of other resources in the production process and by the candidacy of other consumer goods for the buyers' money. Therefore, while the price of a tract of land is set

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2T. W. Schultz states that the substitution of other factors and commodities has in fact reduced the relative value and the absolute importance of land in our economy. (Four lectures at the Land Economics Institute, Urbana, Illinois, June 17-20, 1953).
by the interaction of supply and demand in the market, the analysis of why supply and demand vary may be more fruitful than mere observation of their interaction.³

In accordance with the principle of equimarginal returns, resources should be allocated so that their marginal returns are equal in all of their alternative uses. As applied to land, this principle dictates that users should associate other resources with land as long as, but no longer than, the prospects for returns are better there than elsewhere. Thus, opportunities for other investment, for substitution of other factors of production or other tracts of land in production, or for purchase of other commodities contributing to achievement of the buyers' goals and objectives may be important determinants of demand.

Physical and Economic Supply of Land

Land, as defined by the economist, is the total of natural resources. This is the physical supply. Not all of these resources, of course, are of sufficient utility that they are considered scarce. Only those which are wanted comprise the economic supply.

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³What is empirically observed is not the land market but the market for real estate, i.e., land plus added capital modifying or adding to the land itself.
Man is interested in land either for direct use as a consumption good . . . or as a factor of production. . . . He uses it as an instrument for the creation of economic goods and services . . . or to exchange with others for goods and services. Thus, man selects from the entire physical universe only that part of those resources which can serve in the production of economic goods or satisfy human wants. This serves to distinguish the economic supply from the physical supply of land.4

The economic supply of land is subject to increase or decrease, depending upon the price. More land, or less, will be used in a particular manner as the demands of the consuming public are made known through the pricing mechanism. In Figure 4, as the price offered increases from P to P', the economic supply of land increases from S to S'. The curve of the line suggests that the increase in supply of land is less than proportionate to the increase in price. It is pertinent to observe that an asymptote exists for economic supply of land, and as economic supply is pushed toward the limits of physical supply (S''), the increment in land area either are less productive or are obtained only with greater inputs of labor and capital, so that higher prices for the products of land are needed to justify the use of more land.

Use Capacity

The use capacity of land refers to the capacity of the land profitably to be combined with other resources. Land of low use capacity can be combined with only a small amount of other resources or can show a profit only from extensive use. High use capacity is the power to return a large profit or to persist in profitability when combined with large quantities of other resources. Grazing land and irrigated pasture, or wheat ranching land and land for horticultural crops offer contrasts in use capacity of land for related uses. Location may, of course, be a factor in economic use capacity. The extreme examples of use capacity are land which is virtually worthless for any purpose and land on which skyscrapers are built. Decreasing economic use capacity is illustrated by Figure 5; Figure 6 illustrates...
a closely related concept, that of physical use for biological production. In both of these diagrams, the possibility of alternative uses of land is indicated. A high proportion of the land is adapted to the lower uses; the progressively smaller amounts are suited to the more intensive or higher uses.

When alternative uses are physically possible, the highest and best use should obtain; this is the use which provides optimum returns to the entrepreneur or to society. As the term is ordinarily used, "high" use of land implies application of large amounts of other resources, and highest and best use thus involves utilization of the maximum use capacity of the land. Highest and best use can and does shift, depending on many variables which include the time preference scale or discount schedule used, the viewpoint of the individual as opposed to the viewpoint of society, the level of technology or "state of the arts," the demand for land for various purposes and at various locations, and the nature of the land itself which is not constant over time.

Figure 5. Land Use Capacity and Overlapping Ranges of Highest and Best Use
Figure 6. Physical Use Capacity of Land for Biological Uses

Relation of land limitations and land-capability classes to safe land use

Suitable for:

- Very intensive cultivation
- Intensive cultivation
- Moderate cultivation
- Limited cultivation
- Intensive grazing
- Moderate grazing
- Limited grazing
- Forestry
- Wildlife, recreation,

Land-capability classes: Increasing limitations and hazards; decreasing adaptability and freedom of choice of uses

Extensive and Intensive Margins of Land Use

Land is not uniform in its productive capacity or in the cost of producing whatever output it yields. Differences in cost of production can stem from the inherent variation in the land, from location and costs of transporting the product to market, or from non-land factors. The price of the product, however, is determined in the competitive market and is (theoretically) uniform for all of that product. Value of output thus may exceed cost of production by differing amounts for various tracts of land; this excess of returns over cost is economic rent. On some land, costs of production are high, or the yield is small or sells for a low price. Under these circumstances value of output may fail to cover costs. The point at which output barely covers production costs leaving no surplus or rent is the extensive margin of land use. Viewing land as a continuum of qualities, use of land for agriculture or any other purpose should extend only to those qualities on which production is economic, and land beyond the no rent margin should be withdrawn from (or never entered into) production.

As more labor and capital are applied to or expended upon a given area of land, the production from that land may be expected to rise, within limits. This generality applies to use of more seed, fertilizer, tillage, harvesting care, etc. in agricultural production; it is none-theless applicable to non-farm uses of land. An apartment house represents more labor and capital applied to a city lot than does a one-family dwelling, and the rental income from the lot likewise increases. Increasing returns to increments of labor and capital may be encountered; ultimately, marginal yields decline and finally become negative. Within
the zone of economic choice rational decision as to proportion of inputs
must be related to costs and returns. The intensity of use of a tract
of ground must be governed by the cost of the labor and capital inputs
required and the value of the yield or output expected at each of the
contemplated degrees of intensity.

On land of higher use capacity, the total returns continue to
increase over a more extended range of inputs, and the use of more of
other factors can be justified. However, the extent to which greater
intensity in use is profitable and, therefore, economically justified
depends on the cost of inputs and the value of output. These same
factors affect the extensive margin.

Figure 7 indicates the interrelationships between the intensive
margin and the extensive margin of land use. Use of land for agricul-
tural crops is illustrated; the same principles apply to other uses, for
each use of land has both an intensive and an extensive margin. The
same factors of price relationships and existing technology or state
of the arts determine both margins and fix the position of the diagonal
line M. Use for cropland necessitates a minimal input of other factors
(labor and capital) equal to F. The extensive margin for cropland is
land of use capacity L; poorer land cannot justify the minimal inputs
required to raise crops.

For land of greater use capacity L' larger inputs of other resources,
i.e., more intensive use, is justified up to amount F', at which point
the other factors become unprofitable; the intensive margin of land use
is thus established.
Shifting price relationships and technological advance may move the margin of land use to $M'$. Land of lower use capacity $L''$ can now be used for cropland as the inputs ($F$) required for this use now can be paid. Land of capacity $L$ can now justify more intensive use and additional units of other factors (up to $F'$), while still better land or more favorably located land $L'$ can pay the cost of inputs up to $F''$.

Figure 7. Interrelationship of Intensive and Extensive Margins of Land Use

A shift in the margin in the other direction to $M''$ could be brought about by unfavorable prices for the product relative to the cost of the factors of production. Land of use capacity $L$ and $L''$ now become submarginal for cropland use as they cannot pay for the inputs required. Land of use capacity $L'$ is now at the extensive margin of land use and its intensive margin is $F$, the minimum input requirements.
Only on land of still greater use capacity can more intensive application of labor and capital be justified.

Lags in Adjustment at the Extensive Margin

The foregoing discussion of adjustments at the margins of land use has disregarded the problem of time lags in adjustment. At the intensive margin, little problem exists, for adjustment to either increase or decrease in price is quite rapid.

Adjustments in supply of land, however, do not come instantaneously or even rapidly. If price indicates that more land should be used for farming, for example, it may take several years before additional land can be cleared of trees, stumps, and rocks and made ready to yield a crop. Furthermore, the cost of changing the use of the land may be considerable, and favorable product prices for many years required to repay the costs. Since neither yields, costs of changing the use, nor price of output is likely to be known with any certainty ex ante, increases in land areas in response to increase in current prices are likely to come only slowly, and as continuation of favorable price relationships dispels doubts as to the profitability of the venture.

The decision to change the use of land may be erroneous even though made thoughtfully. Realized returns (ex post) may be less than those anticipated (ex ante). Such results, whether errors of judgment or due to exogenous changes in prices or technology, may lead to land being used in situations that do not cover all costs.

Decreases in land area for a particular use may come even slower than increases. Some slowness to adjust may be based on hope that
prices will improve, but more important is the cost principle. Some of
the costs of production, once committed, are fixed or sunk for many
years regardless of subsequent production. Development costs, or costs
of changing land from one use to another, are important among these
fixed costs. Production should be continued or the land kept in its
current use as long as receipts exceed variable costs. These sunk
costs are not variable in the short run, and continuation of production
until they become variable (i.e., until the resources which they repre-
sent require replacement) is economically sound. Thus production or
use may continue in a submarginal or surplus land area for many years
after the need has vanished which caused the land to be brought into
production originally. Urban slums and submarginal farm land are
illustrations of the workings of the cost principle and land use.

**Location of Production and Comparative Advantage**

Because of variations in economic use capacity as a result of
location, a given tract of land may have an advantage over other tracts
for specific uses but not for other uses. Production of certain commo-
dities may be more profitable in some locations than in others. The
principle of comparative advantage is merely the recognition that the
rational individual will produce that commodity or those commodities in
which his economic advantage is greatest or his disadvantage least.
Theory of location of agricultural or other production merely specifies
the factors and the relationship of the factors which influence these
advantages or disadvantages. For the purpose of the analysis in this
study, the gross concept of variation in economic use capacity as a
function of location is adequate theory of location.
Factors in Land Use in Historical Perspective

In order to point out the effect of specific factors on the utilization of land resources of Ohio, an abbreviated resume of certain aspects of Ohio's historical development is desirable. It is not intended that this should be in any respect a thorough or searching study of the colorful history of Ohio. It is rather an interpretation of history from a land economics standpoint.

The prehistoric inhabitants of Ohio are known to us as the Mound Builders. Excavation of their mounds reveals some indication of the agricultural and hunting prowess of these people, but little can be said of their allocation or use of land resources. However, it is pertinent to observe the geography of the area where the mounds were built. The geologic setting provided such minerals as the mound builders were able to utilize. Forested hills provided hunting grounds. Fertile soils of river valleys provided the base for their agriculture. Humid climate provided adequate water, and the temperature favored both natural productivity and human vigor. The physical and biological framework thus seems to have been the dominant influence in the utilization of resources by the Mound Builders.

The Indian tribes who contested the white man's claim to Ohio were strongly influenced in their use of land by the institutional framework of land use. Physically, Ohio was suited to more intensive culture than it was given by the Indians. Almost without doubt, the standard of living, in terms of nutritional adequacy and certainty, was better for the settlers than for the semi-nomadic Indians. Yet the Indians retained their mode of life because it was their birthright and their
culture, and this traditional pattern of behavior was vital in their value system. The opportunity to change to a different pattern was not given to most of the Indians by the white man; here again the cultural patterns and accepted standards of behavior among the whites influenced land use by precluding peaceful coexistence in the Northwest Territory.

Early settlements in Ohio were in the eastern portion for the simple reason of physical proximity to the origin of the settlers. Dependence on water transportation dictated location of early communities on navigable streams. The hill areas of southeastern Ohio were settled, much of the land cleared, and farmed before the level areas of the West and Northwest because, under the conditions of those times, hillside land was to be preferred for reasons of health, defense, ease of clearing, better drainage, lighter soils, etc. Furthermore, under a system of self-sufficiency in agriculture and with the existing technology, most of this land was supermarginal (i.e., fairly well adapted) for the pioneer type of agriculture.5

The commercialization of agriculture in Ohio was delayed by the difficulties of transporting the products to market. Subsistence-type agriculture was the norm for the pioneer farmer, and it was not until the canals and later the railroads offered a means of transporting agricultural produce cheaply and in volume that the Ohio farmer could

5The advantages which led to early settlement of southeastern Ohio are clearly described and discussed by John H. Sitterley in "Adjustments in Land Use at the Extensive Margin of Farming in Ohio" (unpublished Ph.D. dissertation, The Ohio State University, 1944), Chapter V, especially, pp. 80-86.
develop an orientation or sensitivity to market demand. Maximization of monetary income then became for the first time a factor and a goal in the organization of the typical Ohio farm, bringing to the forefront the economic framework as an influence in the use of land.

The acreage and number of farms in Ohio increased until about 1900. Other activities and industries which had grown along with farming began after the turn of the century to compete effectively for the land resources and the man-power used in agriculture in many sections of the state. The relative decline of agriculture can be explained in terms of opportunity cost, for both land and human resources were frequently more productive in industry and commerce; consequently, they were allocated to their most profitable use.

This competition for the use of land continues. The resulting reallocation of land resources gives rise to a land use situation in which the present study is propitious. The desire or ability of individuals to maximize their satisfactions via allocation of owned or controlled land resources is neither denied nor questioned. However, society must plan ahead to anticipate and attempt to fulfill the needs of the ongoing society into an indefinite future. Conceptually, the needs of the community may be at variance with the interests and desires of individuals, as a result of the difference in the rates by which individuals and society discount future income. May not the temporal advantages of transferring land resources to non-agricultural uses decrease and in time disappear or be overridden by societal concerns, as our growing population increases the demand for food?
It would appear that this will eventually and inevitably occur unless advances in technology and the quality of farming increase as rapidly as the population increases.

Agriculture is not a declining industry. In some parts of Ohio, it is expanding for precisely the same economic reason which elsewhere explains industry's gain: it is better than the alternatives. Elsewhere, particularly in the less profitable and less productive regions, agriculture tends to hold its rank in spite of being poorer than the alternatives. Here institutional factors are dominant; like the Indians before them, these farmers tend to cling tenaciously to their traditional pattern of behavior, a mode of life to which adherence will not weaken while there is life.

The establishment of villages and their growth into cities have roots in the gregarious nature of humanity and in the mutual advantages of proximity. Evolution has completed a full swing of the pendulum; cities originally created as centers of defense have developed as centers of commerce and of production and are now under pressure to decentralize or dispense as a defense measure. Early dependence on communication and mass transportation forced the compact development of cities; now the "state of the arts" in communication permits and in transportation virtually forces loose or sprawling development of cities.

The location of cities with respect to trade routes has been a vital factor in their growth. Cleveland and Cincinnati early dominated the commerce of their areas because of access to water routes. Toledo looms as a grain port of increasing importance because of her location
with respect to both supply (production of grain) and the St. Lawrence Seaway. With respect to industrial or commercial development, the location of Ohio has proved to be so great an advantage that it has been called "an inexhaustible resource." The great funnel formed by the Laurentian Upland on the north and the Appalachian Highlands on the south channels through Ohio the transportation routes between the heavily populated east and the resources of the west. This well-established corridor of east-west trade confers a locational advantage on the northern part of the state and on the southern fringe bordering the Ohio River.

The location of industry in its infancy was determined by the location of the resources and markets needed. Water for power and transport, minerals, coal and forests as raw materials, man-power, ingenuity, money, and entrepreneurship: all of these factors of production had to be in juxtaposition for the successful establishment and continuation of industry. In general, those sites which offered juxtaposition of the essentials became industrialized, while others without the proper combination failed to attract industry. There undoubtedly are many cases which contradict this statement—many sites which have most or all of the listed resources and still do not attract or generate industry. The intangibles of ingenuity and entrepreneurship appear to

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be attracted in quantity to sites which already have industry; thus,
even location of industry seems to be subject to institutional
influences.

Innumerable examples of the interrelated effects of the physical,
economic and institutional frameworks on industrial location and land
use can be found in the economic geography of Ohio; the following
quotations are exemplary. Alfred J. Wright, describing the develop­
ment of the machine tool industry in the Miami Valley, points out the
effect of custom, traditions or accepted patterns of behavior in this
passage:

It is axiomatic that machine-using regions tend to
become machine-making regions. The machine shop is the
market for the machine tool, and the shop will be located
where machinery is to be replaced or repaired. . . .
In the Miami Valley the industrial experience in farm
machinery manufacturing created location factors attrac­
tive to the machine industries already noted, leading
ultimately to the manufacturing of machine tools.7

The same writer makes clear the workings of the threefold frame­
work in the rise and fall of the charcoal iron industry in south­
eastern Ohio.

Accustomed to the small neighborhood blast furnaces
in the East which had supplied iron for their households
and farming needs, pioneers in Ohio sought to establish
similar furnaces and forges in their new home /institutional influence/. In this they were encouraged by the
natural resources of the region and the rapid populating
of the Ohio country. Trees for charcoal, iron ore, and
limestone were widespread throughout eastern Ohio's
Plateau Counties /influence of physical resources/.

7 I b i d . , p . 1 1 2
Ohio's charcoal iron industry remained a small-scale industry. The excellence of the product, the market in nearby steel-using districts, and the persistence of the enterpriser enabled this industry to linger until the early 1900's. By that time the growing size of the furnaces in Pittsburgh and the lake shore centers had made these pioneer furnaces relatively high cost. Upper Lake iron ore was cheaply moved a thousand miles by lake freighter, and the steel market was moving west/influence of economic factors/.

Rural-urban migration has long been a feature of our society. Higher birth rates in the rural areas, coupled with superior economic opportunities in the urban areas, have led to migration of the surplus of young adults to the city. Of recent years, another form of migration has become important; the population of cities has seemingly burst asunder the boundaries of the metropolis, and residential or "bedroom" communities ring the central city in ever-widening circles.

Physical problems of access are important; institutional factors make themselves felt as a more decentralized population, driving more cars, forces provision of larger parking areas and more expressways.

The tendency of cities to "sprawl" is broader than residential use; commercial and industrial users of land also are subject to this centrifugal force, and susceptible to the attraction of lower opportunity costs of land at the urban periphery. A part of the attraction of the periphery is that development costs can frequently be transferred by the individual to society. Examples of such transference are found in housing developments with substandard water and/or

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8 Ibid., pp. 165-167.
sewerage systems that must be later corrected by projects underwritten or subsidized by the community, and the building of houses and industries along highways limiting their usefulness and ultimately requiring their replacement with other transportation routes.

What of the future in Ohio? The population of the area has grown from some 10,000 (Indians) in 1788 to about 10 million in 1960. With 1000 times as many inhabitants, the state has the same surface area but qualitatively and quantitatively less of many resources. Forest reserves in Ohio have been materially reduced. Soil resources have suffered from deterioration and erosion, and some areas have been seriously damaged. Significant proportions of our mineral wealth have already been exploited. Even our land has been reduced, in a sense, at least the physical area available for agriculture. Artificial lakes and reservoirs cover parts of it, and concrete and black-top pavements effectively preclude economic reversion to agricultural use.

With dwindling areas of virgin resources, declining productivity of some of the land which is already in use, and continually increasing population, a rational answer is needed to the question, how shall the land be utilized? The time is long since past when it made no difference whether we considered the morrow. The myth of "inexhaustible reserves" has been debunked.

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The planning of our future allocation of land must consider not
only the amount of land available but also its productivity in various
combinations, the economics of these combinations relative to maximiza-
tion of the goals of society, and the legal, sociological, psychological
and other institutional aspects of various possibilities in land use.
But the planning must be done, lest we as a society find ourselves
saddled with increased costs and burdens which could have been avoided.
CHAPTER III
TRENDS AND PROSPECTS IN LAND USE

Introduction

The interrelationships of physical or biological, economic, and institutional factors in the determination of land use in Ohio have been considered from the historical point of view. It should not, of course, be inferred that this threefold framework is a rigid or unchanging one. Some of the factors, especially the economic factors, are subject to change with considerable celerity.

In the main it is the nature of the other factors to change only slowly. Physical or biological change may proceed at the pace of erosion, or evolution of the species. Some new technological developments may bring to bear at a certain point physical relationships which have not previously been a factor, but even here the impression of change is heightened by contrast with the constancy of the physical universe. Institutional factors develop or evolve gradually and at a slackening pace, tending to become static.

The effect of the threefold framework, in sum, appears to be relatively constant except for the economic factors. It appears, then, that if the effect of changing economic factors can be either held constant or compensated for, the changes in the other factors are likely to be so slight that in the time period of this study they can be disregarded, and a valid study of trends can be made without winnowing out the effects of individual factors.
Long-time Trends in Ohio Agriculture

Census data on land use in Ohio provide the figures necessary for the study of trends. A preliminary study of Ohio land use data shows that trends have not been continuous (see Table 1 and Figure 3). Land in farms and numbers of farms increased as Ohio was settled, continued to increase as the settlers consolidated their holdings, and finally reached an apex around the turn of the century. Since then, both the number of farms and the acreage of land in farms have declined; the resources involved have continually moved toward higher or more remunerative uses. Farm land which had urban use alternatives was shifted to those uses. Where labor and capital in farming had better alternatives than those in agriculture, they too were transferred, with the result that the land reverted to less extensive agricultural or forestry uses.

While there has been no break in the trend toward higher uses of all resources aggregatively, the use of the land resource has undergone a distinct break in its pattern of change. Therefore, it is necessary to truncate the series on use of land even though part of the components are available for earlier dates.
### Table 1

**Number of Farms and Land in Farms, Absolute and as Percentage of 1900, Ohio, Census Periods 1850-1955**

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Farms</th>
<th>Total Land in Farms (acres)</th>
<th>Percent of 1900</th>
</tr>
</thead>
<tbody>
<tr>
<td>1850</td>
<td>143,807</td>
<td>17,997,493</td>
<td>52.0%</td>
</tr>
<tr>
<td>1860</td>
<td>179,889</td>
<td>20,472,141</td>
<td>65.0%</td>
</tr>
<tr>
<td>1870</td>
<td>195,953</td>
<td>21,712,420</td>
<td>70.8%</td>
</tr>
<tr>
<td>1880</td>
<td>247,189</td>
<td>24,529,226</td>
<td>89.3%</td>
</tr>
<tr>
<td>1890</td>
<td>251,430</td>
<td>23,352,408</td>
<td>90.9%</td>
</tr>
<tr>
<td>1900</td>
<td>276,719</td>
<td>24,501,985</td>
<td>100.0%</td>
</tr>
<tr>
<td>1910</td>
<td>272,045</td>
<td>24,103,708</td>
<td>98.3%</td>
</tr>
<tr>
<td>1920</td>
<td>256,695</td>
<td>23,515,888</td>
<td>92.8%</td>
</tr>
<tr>
<td>1930</td>
<td>219,296</td>
<td>21,514,059</td>
<td>79.2%</td>
</tr>
<tr>
<td>1940</td>
<td>233,783</td>
<td>21,907,523</td>
<td>84.5%</td>
</tr>
<tr>
<td>1950</td>
<td>199,359</td>
<td>20,969,411</td>
<td>72.0%</td>
</tr>
<tr>
<td>1955</td>
<td>177,074</td>
<td>19,991,596</td>
<td>64.0%</td>
</tr>
</tbody>
</table>

\(a\)The total area of the state was given by the 1920 census as 26,073,600 acres.

**Source:** Reports of the U. S. Government censuses of agriculture from 1900 through 1954. Complete citations are given here; subsequent citations will be abbreviated.


Figure 8. Number of Farms and Land in Farms, Expressed as Percent of 1900, Ohio, Census Periods 1850-1955

Source: Table 1.
Agricultural and Urban Areas of Ohio

An attempt has been made to present an understandable and informative verbal picture of evolving patterns of land use, with discussion and analysis of some of the factors conditioning this evolution. The aggregative land use pattern of Ohio will be discussed, with some description of the changes, their direction, rate, and interrelationships, for the state as a whole. Subsequently a similar analysis, with a more critical inquiry and analysis of certain strategic uses of land, will be applied to three of the component areas of the state.

For purposes of both description and analysis, the highest possible degree of uniformity or homogeneity of resources and economic conditions is desirable within areas which are to be handled aggregatively. A generalized soils map is the ideal initial basis for dividing areas to achieve homogeneity of soil resources. Such a map is presented in Figure 9.

Economic development or degree of urbanization also supplies a useful basis for division. Exclusion of highly urbanized or built-up areas is as important to homogeneity of agricultural conditions as is proper soils data. In some areas, where emphasis is properly placed on urban rather than rural or agricultural development and where moderate variations in soil type, condition and productivity are recognized to play only a minor role, the aggregation of the area may properly be based on the influence of urbanization.
Figure 9. Generalized Soils Map of Ohio

Key to Soil Areas

- Morley, Blount, Pewamo
- Hoytville, Kappanee, Fulton, Toledo, Paulding, Latty, Bedrow, Granby, etc.
- Miami, Celina, Crosby, Brookston
- Russel, Xenia, Fincastle, Brookston, Reesville, Ragsdale
- Caneadea, Canadice, Lorain, Monroeville, Plainfield, Wilmer
- Ellsworth, Mahoning, Trumbull, Cambridge, Venango
- Alexandria, Cardington, Bennington, Marengo
- Rittman, Wadsworth, Trumbull
- Wooster, Canfield, Ravenna, Trumbull
- Cincinnati, Rossboyne, Avonburg, Clermont, Jessup, Loudon, Edenton
- Hanover, Fallsburg
- Muskingum, Wellston, Keene, Upshur, Westmoreland, Meigs
- Fairmount, Maddox, Heitt, Bratton, Zagerstown, Cedarville

Since collection of data is universally based on political rather than geologic, agronomic or economic areas, it is necessary to compromise with ideal divisions and follow the county boundaries nearest the desired natural boundary. Figure 10 shows the compromise which has been accepted for this study.¹ Eleven agricultural areas are demarcated, leaving 9 urban counties. The urban counties are divided into the East and West Urban Areas, based on their geographical separation and the difference in character of soils.

The component areas of Ohio which will be considered in some detail have been selected as those which are exemplary of the widely divergent patterns of soil and economic conditions and of evolving land use which exist concurrently:

Area 1, a 9-county agricultural area in northwestern Ohio, which is exemplary of trends toward intensification and extensification of agriculture;

Area 10, a 10-county hill area in southeastern Ohio, which typifies the retirement of sub-marginal farmland and which also has problems of mineral land use;

Area Urban-East, in northeastern Ohio, a group of 5 contiguous counties wherein the urban influence is dominant over agriculture, and which consequently typifies the problems of urbanization, urban "sprawl" and supercession of agriculture.

¹The Ohio Committee for Inventory of Soil and Water Conservation Needs used this division in 1958. Their precedent, followed in this study, is hereby acknowledged.
Figure 10. Agricultural and Urban Areas of Ohio as Divided by Conservation Needs Committee

- Agricultural areas
- East urban areas
- West urban areas
Agricultural Census Data and the Conservation Needs Inventory

Some explanation is due regarding the use of agricultural census data in this study. For ease in comparing data and computing trends and rates of change, it is desirable to use series with observations at equal intervals. The decennial census provides equally spaced observations. In order to bring the study up to date, or as nearly so as possible, the 1954 census has been included. However, data from this census is referred to throughout this study as 1955 data. This is not an accident or an oversight but a deliberate attempt to represent the data in its true relationship to the series of which it is a part.

Census periods used are all even decades, except 1954. Use of the nominal census date 1954 would indicate a four-year interval since the 1950 census. However, the land use reported in these censuses is the land use of the preceding year (1899, 1949, etc.) in every case except 1954 so that the interval in actuality is five years rather than four. Land in farms is the land inventory at the date of the census enumeration. For the census of 1950, this date was early in the nominal census year, while for 1954, it was late in the year, resulting in an interval of some four years, seven months—nearer to five years than to four.

Accuracy of implication as to interval between censuses could be achieved by using the dates, 1899, 1909, 1919 . . . 1954. This practice would have required changing the designation of six censuses in order to preserve one—and that one being the least institutionalized. Since no loss of accuracy relative to other census data results, the convention is followed of designation by even decades or half decades.
Preliminary data of the Ohio Committee for the National Inventory of Soil and Water Conservation Needs are used in several places subsequently as a cross-check on projections made by other methods. A word of explanation may well be given with regard to the source and meaning of these data.

The National Inventory of Soil and Water Conservation Needs was begun under the policies established by Memorandum No. 1396 dated April 10, 1956 and signed by Ezra Taft Benson, Secretary of Agriculture. State committees were organized under the leadership of the Soil Conservation Service. Other federal agencies participating were the Agricultural Conservation Program Service, Agricultural Research Service, Commodity Stabilization Service, Federal Extension Service, Farmers Home Administration and the Forest Service. Additional representatives to the state committees were appointed from landgrant colleges; experiment stations; state departments of natural resources, conservation, water, etc.; and such other organizations or institutions as seemed appropriate to the purposes of the committee.

County committees were formed, with the organization being structurally comparable to the state committees. Local agri-business leaders, farmers and other interested persons could be invited to participate in the work of the committee; such local participation was general in Ohio.

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The county committees were furnished with surveys of the soil and water situation, research studies of physical and economic effects of land management practices, and a basic economic framework of assumptions regarding the general level of prosperity and employment for the nation, and expected land use patterns for the state. These committees then developed county inventories of land use, conservation problems and acreage needing treatment, and estimates of probable land use changes by 1975.

For Ohio, the inventories by the county committees were completed in 1959. Summarization of the reports from the counties was done by the Soil Conservation Service staff under the direction of Horton B. Alger and were made available for this study by him. These data are referred to as "preliminary" because they have not yet been finally approved by the national committee.

The data of the Conservation Needs Committee are not exactly comparable to census data. In general, this is because census data on land use are based on land in farms, whereas the Conservation Needs Inventory pertains to all land, in or out of farms, except that which is federally owned or is built up or inundated. These non-comparable classes reduce the utility of these data below the ideal. However, the direction and general magnitude of changes in classes that are approximately comparable can be utilized as landmarks or beacons in a territory without other navigational or predictive aids.
Ohio: Aggregative Land Use Patterns

Viewed aggregatively, land use in Ohio since 1900 shows a slowly decreasing acreage of arable agriculture and an increase in non-farm land. This general conclusion is derived from the data of Table 2 and Figure 11. Analysis of the component uses of land improves the accuracy of the picture and suggests reasons for the trends observed.

Before undertaking this analysis of components, a word of explanation and precaution is necessary with respect to the charts and use of trends.

Figure 11 and comparable charts used subsequently are absolute component band charts, in which the width of each band corresponds to the acreage in that use of land as shown in the accompanying table. The relative importance of the various land uses can be seen at a glance from the relative widths of the bands. The trends in area of land in each use are not so readily apparent, for the base or zero line for each use is the total acreage of the uses shown below it on the chart. For example, in Figure 11, the upper margin of the band representing hay declines from 1900 to 1910 and rises slightly from 1910 to 1920; but the width of the band (acreage of hay) increases from 3 million in 1900 to 3.2 million in 1910 and decreases to 3 million in 1920. Thus, the change in acreage can be determined from the chart only by referring to both margins of the band. Acreage is, of course, available directly from Table 2.
Table 2

Land Utilization in Ohio by Census Periods, 1900-1955
and Projection of Trend to 1975 and 2000
(Thousand of Acres)

<table>
<thead>
<tr>
<th></th>
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<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cropland:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intertilled Crops</td>
<td>4,167</td>
<td>4,367</td>
<td>4,088</td>
<td>3,827</td>
<td>4,426</td>
<td>4,494</td>
<td>4,790</td>
<td>4,711</td>
<td>4,931</td>
</tr>
<tr>
<td>Small Grains</td>
<td>4,389</td>
<td>3,735</td>
<td>4,639</td>
<td>3,366</td>
<td>2,941</td>
<td>3,506</td>
<td>2,915</td>
<td>2,515</td>
<td>1,899</td>
</tr>
<tr>
<td>Meadow Cut as Hay</td>
<td>3,015</td>
<td>3,176</td>
<td>2,998</td>
<td>2,625</td>
<td>2,356</td>
<td>2,124</td>
<td>2,537</td>
<td>1,946</td>
<td>1,539</td>
</tr>
<tr>
<td>Total of Crops Specified(b,c)</td>
<td>11,571</td>
<td>11,268</td>
<td>11,724</td>
<td>9,818</td>
<td>9,723</td>
<td>10,124</td>
<td>10,241</td>
<td>9,172</td>
<td>8,369</td>
</tr>
<tr>
<td>Woodland in Farms</td>
<td>NR(d)</td>
<td>3,285</td>
<td>3,199</td>
<td>2,774</td>
<td>2,413</td>
<td>3,047</td>
<td>2,908</td>
<td>2,667</td>
<td>2,447</td>
</tr>
<tr>
<td>Other Land in Farms</td>
<td>12,931</td>
<td>9,552</td>
<td>8,593</td>
<td>8,922</td>
<td>9,771</td>
<td>7,799</td>
<td>6,842</td>
<td>6,852</td>
<td>5,869</td>
</tr>
<tr>
<td>Total Land in Farms</td>
<td>24,502</td>
<td>24,106</td>
<td>23,516</td>
<td>21,514</td>
<td>21,908</td>
<td>20,969</td>
<td>19,992</td>
<td>18,691</td>
<td>16,685</td>
</tr>
<tr>
<td>Non-Farm Land</td>
<td>1,572</td>
<td>1,968</td>
<td>2,548</td>
<td>4,560</td>
<td>4,166</td>
<td>5,104</td>
<td>6,082</td>
<td>7,383</td>
<td>9,389</td>
</tr>
<tr>
<td>Total Land Area(c,e)</td>
<td>26,074</td>
<td>26,074</td>
<td>26,074</td>
<td>26,074</td>
<td>26,074</td>
<td>26,074</td>
<td>26,074</td>
<td>26,074</td>
<td>26,074</td>
</tr>
</tbody>
</table>

\(a\)Projections are based on a straight line trend fitted by least squares and on sums of projected components.

\(b\)Not to be construed as a total of all crops raised or total harvested cropland.

\(c\)Components may not add to totals because of rounding.

\(d\)NR = Not reported. Separately from other land in farms.

\(e\)For uniformity the area of Ohio as reported in the 1920 Census is used throughout.

Source: Calculations, Censuses of Agriculture, 1900 through 1954.
Figure 11. Land Utilization in Ohio, 1900-1955, and Projection of Trends to 1975 and 2000

Source: Table 2
The projections on the charts and in the tables are based on straight line trends fitted to the data by the method of least squares. The straight line does not, of course, give as good a fit as could have been obtained by using second-degree or more complex curves. Its defense lies in its simplicity of concept and computation, and the considerable improvement which it offers over an average rate of change for the same period. It may be questioned whether the changes in land use can properly be expressed by any mathematical equation. Croxton and Cowden in describing the problem of selection of a trend type point out:

\[3\]

It may be that the series does not conform to any mathematical description. In a dynamic world, the forces in operation are seldom allowed to work out their full effects before other factors make themselves felt. As a result, any trend type may be appropriate for only a relatively short period.\^)

In view of the weaknesses and uncertainties of applicability of the statistical technique of fitting and projecting a trend, it is only reasonable that the trend selected should be as simple as possible. The more complicated and (ex post) more exact trend types are (ex ante) more subject to gross deviation from reality. While they may be more precise, they also may miss by a greater margin.

The straight line trend assumes and projects a constant amount of increase or decrease. This is unrealistic in view of the fact that land use in Ohio cannot exceed the total area of the state, nor can it drop below zero for any component land use. It is highly probable that

these trends do (or will) flatten out as they approach the maximum or minimum, because of the nature of the physical resources. Within the time period of this study, no component of land use increases at a rate which necessitates supplying an asymptote. Some uses are projected to negative figures by straight-line trends; these negative figures are, of course, adjusted to zero. Further modification in the form of specifying the lower asymptote is not done because of its arbitrary nature, but in a few cases attempts are made to describe a reasonable asymptote for a particular use of land.

Intertilled crops have increased by 623 thousand acres, or about 15 percent, since 1900. This is the more notable because of the decrease of 8 percent (340 thousand acres) in the first 30 years; the next 25 years showed an increase of 25 percent from the low point.

The straight-line trend for intertilled crops indicates an increase of 8800 acres (0.2 percent) per year.\(^4\) Projection of the trend at the same rate indicates 4,711 thousand acres in 1975 and 4,931 thousand acres in 2000. Because the dip in the middle of the series reduces the trend value, the indicated acreage for 2000 is only slightly above the actual acreage for 1955 and is, therefore, quite conservative. The introduction of soybeans into Ohio as an intertilled crop was one factor which led to the increase in row crop acreage. The recent spurt in row crop acreage may be attributed in part to agronomic research and the development of cheap nitrogen fertilizers, which have

\[^4\]Y (Acreage of intertilled crops) = 4,050,556 + 8,805X; origin at 1900, X = 1 year.
combined to permit more intensive cropping programs, with a nearer approach toward continuous corn on a successful and profitable basis.

Small grains occupied more land than did intertilled crops in 1900; in 1955 they occupied only 61 percent as much. Except for 1920 and 1950, each census period showed less acreage of small grain than the previous period. A straight-line trend indicates a reduction of over .5 percent per year.\(^5\) Projection of this trend indicates 2,515 thousand acres in 1975 and 1,899 thousand acres in 2000; at this point small grain acreage will be well under half of its 1900 figures.

It may be suggested, without a detailed examination or analysis, that the decline in small grain acreage in Ohio was due to a lessening of the comparative advantage of small grains in Ohio and the farmers' response to changing price relationships. The development of the combined harvester-thresher and the gasoline tractor, which permitted the exploitation of the Great Plains as a producing area for small grains, thus appears to have been closely related to the decline in small grain acreage in Ohio since 1920. At the same time, greater profits from alternative crops such as corn and soybeans encouraged farmers to shift their emphasis away from small grains.

The increase in soybean acreage probably did not directly cause the decrease in small grain acreage for this decline was relatively less in the latter part of the period when soybeans were more of a factor. To some extent the popularity of soybeans has tended to

\(^5\) \(Y \text{ (small grain acreage)} = 4,363,143 - 24,644X; \text{ origin at 1900, } X = 1 \text{ year.} \)
increase the acreage of fall-sown small grains, because the earlier harvest of beans (as compared to corn picking) facilitates timely sowing.

Acreage of meadow cut as hay has shown a pattern of fairly regular decline except for the first and last periods in the series. Analysis of this pattern on a state-wide basis is of doubtful utility. However, it may be pointed out that the decline is of the same order of magnitude as the decline in total land in farms, and it may be presumed that the decline came about for similar reasons.

The function of the rotated meadow in Ohio agriculture has changed a great deal since 1900, and the importance of rotated meadows is not properly indicated by the acreage of meadow harvested as hay. Sod crops or rotation meadows for production of hay, ensilage, seed or pasture or for soil improvement represent a larger proportion of crop-land and are more important in the agricultural economy than the width of the "hay" band in Figure 10 would indicate.

Projection of the trends in acreage of hay to 1975 and 2000 indicates production of 1,946,000 and 1,539,000 acres, respectively. The latter figure represents just over half of the 1900 acreage. These trends indicate that in terms of acreage the significance of hay is diminishing, although at a slightly slower rate than small grains.

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6 1955 acreage is 84 percent of 1900 acreage for hay, cf. 82 percent of 1900 for land in farms.

7 $Y (acreage of hay) = 3,166,744 - 16,274X$; origin at 1900, $X = 1$ year.
Woodland in farms as measured by census acreage data shows a trend toward decline.\textsuperscript{8} Acreage figures indicate a rapid decrease and an off-setting increase during this period. This phenomenon can best be interpreted as the result of changes in definitions and significant changes in the geographical components of the series, and further analysis of these components at this time would be premature. The point can be made, however, that because of the vagaries in definition of terms more variation occurs in the woodland data for this period than is likely to have occurred in the woods. Abandonment of agricultural use of a farm, for example, would result in the entire acreage of woods on the land tract in question being removed from the woodland in farms category, thus showing a decrease in land in farms. However, the real effect of this abandonment on total area of woodland would be no change at first, but an increase within a few years as the non-forested area of the farm was rapidly reforested by the forces of nature. It is important to note that woodland in farms does not include or in any way take account of woodland or forests in tracts on which there was no agricultural operation. This is particularly important in southeastern Ohio, as will be noted subsequently.

The decline in woodland in farms amounts to about 11 percent in 45 years. Further decline is projected as a comparably slow rate so that indicated acreage by 2000 is still 74 percent of the 1910 census figure.

\textsuperscript{8}X (woodland in farms) = 3,237,846 - 8786X; origin at 1900; X = 1 year.
Thus, of the biological uses of land, the most intensive (intertilled crops) and the least intensive (forestry) show the only increase and the smallest decrease. It might logically be expected that the amount of land in each of these and other uses would stabilize or come to equilibrium at the acreage of land which is better adapted to that use than to any other. The location of such asymptotes and the approach toward them by these uses will be further analyzed with the geographic breakdown of the census data.

Total land in farms, as the term is used in census data and in this study, is not a total of the foregoing components. The sum of the acreages of intertilled crops, small grains and hay is a rather close approximation of harvested cropland in most years. However, between these intensive (crop) uses and the non-intensive use for forestry there is a complex of uses which defies or at least resists analysis. The most intensive land use on the farm, sites for buildings, is in this category, as is the least intensive use, wasteland. Other uses, including permanent pasture, lanes, ditches, idle land, and meadow land harvested directly by livestock (as pasture) are swept into this catch-all category. This veritable hodge-podge of land uses can be determined as a residue, by subtracting the known categories (with continuous or comparable series) from the total of land in farms. It appears that any analysis done on this "other uses" category must be rather superficial in view of the nature of the data. No trends were computed for this category of land use. Inspection of the graphic portrayal of trends in land utilization (Figure 11) makes it rather evident that the catch-all
category is catching less as time goes on. Some of this is easy to understand, as pasture land is upgraded for use as cropland. More upgrading may be occurring than increase in crops would indicate, for rotated cropland in meadow harvested by livestock as pasture or harvested for seed would not show in the classification used here. In addition, a high proportion of the agricultural land which is being urbanized is good land, suitable for cropland use. This land must be replaced--ordinarily by upgrading of other land in farms--in order for the basis for arable agriculture to continue.

The total acreage of land in farms is naturally dependent on the definition of a farm. Because of changes made in this definition from time to time, this series is not wholly comparable or consistent.

In the early part of the series, a farm was so defined for purposes of the Census of Agriculture if it required "the entire time of at least one individual" or "the continuous services of at least one person." In the 1920 census, the labor requirement was alternative with a value of output requirement: a tract of less than 3 acres could be listed as a farm regardless of labor requirements if it produced at least $250 worth of farm products annually. For the 1930 census, the alternative qualification of a farm based on labor needs

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11 Ibid.
was eliminated, but the $250 minimum value of farm products required for qualification as a farm was retained without other change. For the 1940 census, the $250 limitation on value of products did not apply to tracts larger than three acres, but such tracts must have had agricultural operations performed in 1939 or contemplated in 1940. For the 1950 census, tracts of over three acres were not considered farms unless they produced farm products, exclusive of the home garden, worth $150; places under three acres were counted as farms only if annual value of sales of agricultural products exceeded $150.

These changes in definition obviously would influence the number and acreage of small farms. In 1954, 16,340 farms in Ohio were smaller than 10 acres. Numerically, these farms constituted 9.4 percent of the 177,074 farms in the state; but they averaged only 4.6 acres per farm and their combined acreage accounted for only 0.4 percent of the land in farms in Ohio. Had these changes in definition eliminated all of those small farms, the effect on the aggregate acreage of land in farms would have been hardly noticeable except in detailed analysis.

Less obvious and more difficult to assess is the influence on larger farms. The change in the 1950 census definition of a farm resulted in enumeration of 17,026 farms which would have been counted

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as farms under the 1940 definition but which were not so counted in 1950.\textsuperscript{16} A total of 61,875 places in Ohio were enumerated but not counted as farms; this figure includes the 17,026 already mentioned. The average size of these places enumerated was 25 acres. The average size of the 17,026 is not known, but if their average size was the same as the rest of the group (25 acres), their exclusion in the 1950 census reduced the acreage of land in farms in Ohio by (17,026 \times 25 \text{ acres} =) over 400 thousand acres or 2.1 percent of farm area. Worse yet, this loss seems likely to have fallen largely in some category such as sub-marginal woods and brush farms, where the effect on acreage of woodland in farms could be very significant.

Thus, it appears that the inconsistency or non-comparability within this series; and the variation in acreage of land in farms resulting from such non-comparability, may be negligible or may be highly important. In either case no satisfactory adjustment or correction can be made. Consequently, the whole problem of non-comparability and internal inconsistency is ignored in the balance of this analysis.

In the aggregate, the land in farms in Ohio has been declining at a rapid pace. For each 100 acres of farm land in 1900, less than 82

acres remained in 1955. If the trend continues, over 80 thousand acres will continue to be withdrawn from the "land in farms" category annually, and by 2000 only 68 acres will remain of each 100 acres in farms one century earlier.

The foregoing projection of land use patterns in Ohio to 1975 and 2000 has been based on a simple linear trend. Factors which would modify the trend have been discussed, but their probable effects have not been incorporated into the projection. Of course, no one can say in advance that one projection is right and another wrong, or even with any certainty that one is better than another. If such were possible, prediction would become identical with historical study. However, comparison of projections or predictions made by different methods should prove fruitful because any agreement, whether in amount, in proportion or only in direction of change, tends to strengthen both projections.

Table 3 presents in summary form the most recent inventories, projections to 1975, and amount and percent of change for the linear projection from census data and for the projections of the Conservation Needs Inventory Committee (this committee and its work was described on pp. 52-53). It must be emphasized that the classes used in these two projections are only approximately comparable.

\[ Y (\text{land in farms}) = 24,707,687 - 80,226X; \text{origin at 1900}, X = 1 \text{ year}. \]
### Table 3

Inventory, Projection, and Change in Land Utilization, Ohio
(Thousands of acres)

#### A. Based on Census Data

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Inventory 1955</th>
<th>Projection 1975</th>
<th>Change Amount</th>
<th>Change Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total of crops specified</td>
<td>10,241</td>
<td>9,172</td>
<td>-1,069</td>
<td>-10.4%</td>
</tr>
<tr>
<td>Woodland in farms</td>
<td>2,908</td>
<td>2,667</td>
<td>-241</td>
<td>-8.3</td>
</tr>
<tr>
<td>Other land in farms</td>
<td>6,842</td>
<td>6,852</td>
<td>+10</td>
<td>+0.1</td>
</tr>
<tr>
<td>Total land in farms</td>
<td>19,992</td>
<td>18,691</td>
<td>-1,301</td>
<td>-6.5%</td>
</tr>
<tr>
<td>Land not in farms</td>
<td>6,082</td>
<td>7,383</td>
<td>+1,301</td>
<td>+21.4%</td>
</tr>
</tbody>
</table>

Source: Table 2 and calculations.

#### B. Based on Conservation Needs Inventory Committee data.

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Inventory 1958</th>
<th>Projection 1975</th>
<th>Change Amount</th>
<th>Change Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cropland and rotated pasture</td>
<td>12,654</td>
<td>11,993</td>
<td>-661</td>
<td>-5.2%</td>
</tr>
<tr>
<td>Woodland</td>
<td>5,164</td>
<td>5,174</td>
<td>+10</td>
<td>+0.2</td>
</tr>
<tr>
<td>Pasture and range</td>
<td>3,360</td>
<td>2,835</td>
<td>-525</td>
<td>-15.6</td>
</tr>
<tr>
<td>Other land</td>
<td>2,386</td>
<td>2,163</td>
<td>-223</td>
<td>-9.3</td>
</tr>
<tr>
<td>Inventory acreage</td>
<td>23,563</td>
<td>22,165</td>
<td>-1,398</td>
<td>-5.9%</td>
</tr>
<tr>
<td>Excluded area</td>
<td>2,657</td>
<td>4,054</td>
<td>+1,397</td>
<td>+52.6</td>
</tr>
</tbody>
</table>

Source: Preliminary data, Ohio Committee for the National Inventory of Soil and Water Conservation Needs.

Cropland and rotated pasture (Conservation Needs data) includes a wider range of land uses than does the total of crops specified (census data), and naturally its acreage is greater. Inclusion of rotation pasture (1,710 thousand acres in 1955) would bring the census cropland figure to nearly 12 million acres and miscellaneous crops and idle land explain the remainder. Projected change is less for Conservation Needs
yet both show sharp decreases. The smaller decrease in Conservation Needs projections may be explained by the recognized tendency for trends to level off. In this study historical trends in census data have been projected at constant annual amounts of change. These trends are thus steeper than might reasonably be expected in the future. The C.N. trends not only project change at a slower than historical rate, but this rate may be further slowed over time.

Area of woodland in farms (census) shows a continuation of downward trend; but as has already been pointed out, this decline is largely due to the definition of the class, rather than a reduction of total woodland. The stability of woodland acreage in the C.N. projection substantiates this diagnosis.

Other land in farms (census) is so different in compass from other land (C.N.) that no further discussion is justified.

Inventory acreage (C.N.) is the total area less the federally owned cropland, the urban and built-up land, and inundated areas. This figure is somewhat greater than land in farms (census) but the amount and percentage of change show very close agreement. Land not in farms (census) and excluded area (C.N.) show comparable changes in amount; the difference in percentage of change is determined largely by the fact that land in farms (census) includes non-farm woodland.

While the limited degree of comparability of these classes makes comparative analysis difficult and hazardous, it is apparent that a large amount of similarity exists in the projected land use patterns shown in Table 3. While obscured by differences in techniques and
assumptions, both linear projection of historical trends and the
techniques of the Conservation Needs Inventory Committee indicate for
Ohio continued decline in area of cropland and increase in the area of
land subject to the influences of urbanization.

The complement of land in farms is, of course, land not in farms.
The difference between land in farms and the total area of the state is
the non-farm land. As the land in farms has decreased, non-farm land
has increased. It is unfortunate that this category, like the "other
land in farms" category, is a conglomerate of varied uses, the makeup
of which does not remain constant over time.

The lack of adequate statistical data hampers the analysis of the
"land not in farms" category. Fundamentally, a residual category, its
components have not been measured and recorded with the same thoroughness
accorded the components of land in farms, and any analysis made of this
category must, therefore, be based at least in part on other indicators
of land use.

Land not in farms may be divided into three categories: grazing
land not in farms, woodland and forest not grazed, and other land (see
Table 4). These categories are useful as applied to the United States,
and to some of the states or regions, but for Ohio they are virtually
meaningless. Grazing land not in farms, which accounts for nearly one-
half of non-farm land in the United States, is a concept which would be
inadmissible in Ohio were it not for inclusion of land in multiple use--
for example, the grazing of public and private land such as military
reservations and airfields.
Table 4
Acreage and Percentage Distribution of Major Uses of Land
Not in Farms, Ohio and United States, 1954

<table>
<thead>
<tr>
<th>Acreage (1000 Acres)</th>
<th>Percentage Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ohio</td>
</tr>
<tr>
<td>Grazing Land</td>
<td>560</td>
</tr>
<tr>
<td>Woodland &amp; Forest</td>
<td></td>
</tr>
<tr>
<td>Not Grazed</td>
<td>2,028</td>
</tr>
<tr>
<td>Other Land</td>
<td>3,660</td>
</tr>
<tr>
<td>Total</td>
<td>6,248</td>
</tr>
</tbody>
</table>


The "other land" category, being a residue, should be the smallest class (and is, for the U. S. and for many of the states); but it accounts for over 53 percent of the total of non-farm land in Ohio. Further subdivision of this category is desirable, but cannot be done with strictly comparable series, as the needed data are not available.

Some of the components of the "other land" category are listed as "special-use areas." While the available list of special uses does not account for all of the "other land" (2,214,000 acres, of the 3,660,000 acres total), and includes some land which is farm land rather than non-farm land (e.g., farmsteads, farm roads and lanes), it is indicative of some of the uses and their relative importance. These uses for both Ohio and the United States are shown in Table 5.

The proportion of non-farm land that is occupied by urban areas is much greater for Ohio than for the United States as a whole. This
relationship is to be expected in a state as heavily industrialized as Ohio. The United States' figure is heavily influenced by the large areas of government-owned, non-farm lands in the far West.

### Table 5

Acreage and Percentage Distribution of Land in Special-Use Areas, Ohio and United States, 1954

<table>
<thead>
<tr>
<th>Land Not in Farms&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Acreage (1000 Acres)</th>
<th>Percentage Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ohio</td>
<td>U.S.</td>
</tr>
<tr>
<td>Urban Areas&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1,006</td>
<td>18,561</td>
</tr>
<tr>
<td>Rural Highways, Railroads, and Airports&lt;sup&gt;c&lt;/sup&gt;</td>
<td>520</td>
<td>24,494</td>
</tr>
<tr>
<td>Parks</td>
<td>54</td>
<td>18,724</td>
</tr>
<tr>
<td>Wildlife Areas</td>
<td>38</td>
<td>8,780</td>
</tr>
<tr>
<td>National Defense and Atomic Energy</td>
<td>89</td>
<td>27,395</td>
</tr>
<tr>
<td>Land in Farms&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farmsteads, Farm Roads and Lanes</td>
<td>482</td>
<td>11,008</td>
</tr>
<tr>
<td>State Owned Institutions and misc. other uses</td>
<td>25</td>
<td>1,236</td>
</tr>
<tr>
<td>Total&lt;sup&gt;d&lt;/sup&gt;</td>
<td>2,214</td>
<td>110,198</td>
</tr>
</tbody>
</table>

<sup>a</sup>This separation of special-use areas into farm and non-farm land was not a feature of the source table. It is added for presentation here with the recognition that the distinctions are not clear-cut and that some overlapping exists.

<sup>b</sup>Areas occupied by towns and cities of 1,000 population and over as of December, 1954.

<sup>c</sup>Acreage in highways based on average right-of-way width. Airports for personal use, military airports and those within corporate limits of cities are excluded.

<sup>d</sup>Certain special uses of rural land are excluded: reservoirs, industrial sites, mining areas, golf courses, etc.

The increase in industrialization of the state over the past half century would appear to be responsible for at least a substantial part of the increase in non-farm land for three reasons. In the first place, industry must have land on which to locate its factories, warehouses, offices, parking lots, etc. In the second place, the increase in industrialization to some extent both causes and is caused by the increase in population, so that expansion of residential areas and other needs of an expanding population foster growth of non-agricultural and non-farm uses of land. In the third place, the scattered location of industry in Ohio, with industrial plants in virtually every county, has made it possible for many farmers to find employment in industry to supplement or replace their agricultural labors, thus permitting the retirement from farming of some land which otherwise would not have been retired.

If the non-farm land were all urban land or were all directly related to population, the increase in non-farm land would be proportionate to the increase in population. The population of the state has increased from 3.672 million in 1900 to 9.006 million in 1955, or 245 percent of 1900. The non-farm land of the state has increased from 1.57 million acres in 1900 to 6.25 million acres in 1955, or 398 percent of 1900. With the increase in non-farm land more than 1 1/2 times as rapid as the increase in population, it does not appear that the population upsurge is of itself an adequate explanation for the change in non-farm land.
The use of land for transportation purposes, shown in Table 4 as about one-half million acres, has not increased more than a small amount since 1900. Another inventory which shows 692 thousand acres used for transportation in Ohio in 1957 similarly concludes that there has been little increase.18

Estimates of transportation land area are usually based on the average width of roads and reported mileage of roads. It is granted that roads have been widened over the years, and that rights-of-way have also widened. However, the total mileage of roads of all types in Ohio has changed very little over the years (see Table 6). From high point (1914) to low point (1957), the reduction is less than 4 percent. While the widening of roads and rights-of-way probably more than offsets the decrease in length of roads, it is self-evident that the increase in acreage is diminutive relative to the increase in urban area. It is popularly felt that turnpikes and expressways are prodigious users of land. This is hardly the case. The land requirements of the Ohio Turnpike total only about 11 thousand acres, based on 240 mile length and 300-foot average width of right-of-way. This amounts to some 1.5 percent of the transportation use land in the state, and may be compared to the trend value for non-farm land which has shown an increase of 80 thousand acres annually.19

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18 Fred R. Durr, "Transportation and Land Use in Ohio," unpublished report of research in Land Economics at The Ohio State University, 1959.

19 The land actually used for roads and highways is not available in neat, mutually exclusive categories. Some remains as part of the acreage in farms whose boundaries extend to the center of township or county roads with easements for public use. In other cases, title to the right-of-way acreage has been transferred, thus reducing the acreage in farms.
Land area devoted to railroad rights-of-way has been subject to little change, the mileage of road owned by railways in 1957 being within about 5 percent of the 1900 mileage (see Table 7). Land used for canals has ceased to be much of a factor, but even at its zenith it accounted for less than 10,000 acres.20

By contrast to the diminishing land use for land and water transportation, land used for airports has increased from nothing at the turn of the century to about 63 thousand acres in 1959.21

Table 6

<table>
<thead>
<tr>
<th>Date</th>
<th>Mileage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1914</td>
<td>86,354</td>
</tr>
<tr>
<td>1921</td>
<td>84,219</td>
</tr>
<tr>
<td>1930</td>
<td>85,106</td>
</tr>
<tr>
<td>1942</td>
<td>85,659</td>
</tr>
<tr>
<td>1950</td>
<td>86,286</td>
</tr>
<tr>
<td>1957</td>
<td>83,244</td>
</tr>
</tbody>
</table>


20 Durr, pp. 24-27.
21 Ibid., p. 23.
Table 7
Miles of Road Owned by Steam Railways, Ohio, Selected Years 1900-1957

<table>
<thead>
<tr>
<th>Date</th>
<th>Miles of Road</th>
</tr>
</thead>
<tbody>
<tr>
<td>1900</td>
<td>8,807</td>
</tr>
<tr>
<td>1910</td>
<td>9,134</td>
</tr>
<tr>
<td>1920</td>
<td>9,002</td>
</tr>
<tr>
<td>1930</td>
<td>8,804</td>
</tr>
<tr>
<td>1940</td>
<td>8,501</td>
</tr>
<tr>
<td>1948</td>
<td>8,423</td>
</tr>
<tr>
<td>1950</td>
<td>8,418</td>
</tr>
<tr>
<td>1957</td>
<td>8,343</td>
</tr>
</tbody>
</table>


Even with this increase, however, the aggregate amount of transportation-use land in Ohio is relatively stable at roughly two-thirds of a million acres.

As it has already been pointed out (p. 70), farmsteads, farm roads and lanes are a special use of land which belongs in the category of farm land. Since the uses under discussion are related to urban population rather than agricultural production, land for farmsteads, farm roads and lanes will not be commented on in this section.

Parks and wildlife areas may properly be considered together inasmuch as they have the common goal or objective of preserving the wild or natural state of land. The need for land for these uses
generally hinges on a dense population and intensive use of land which preclude recreational or wildlife uses in a supplementary (non-competing) relationship. Since their combined acreage of parks and wildlife area is less than 2 percent of the non-farm land area, perhaps the only comment which is justified is that land in these uses has increased, but less rapidly than the need for it has increased.

National defense uses of land increased during times of war and declined after cessation of hostilities. Atomic installations and military areas have been responsible for a large proportion (4 percent) of non-farm land use on a national basis but the proportion in Ohio has been much smaller.

Another component of non-farm land, which has been mentioned but not discussed, is woodland. As was suggested in the discussion of woodland in farms (pp. 68-69), the retirement of submarginal farmland not only affects the area of land in farms and land not in farms, but the amount of woodland as well. This is particularly applicable to the unglaciated counties of southeastern Ohio, where the soil and climatic factors operate without delay to revegetate farms with forest cover when agricultural use is terminated. The cessation of agricultural production on what were formerly enumerated as farms has had a heavy impact on the land use picture in southeastern Ohio, and in that part of the state has been the primary factor in the expansion of the non-farm land area. The retirement of farm land to the less intensive forest use is not typical of the state as a whole; for this reason further discussion of this aspect of land use will be deferred to a subsequent section.
Other uses of land which are included in the non-farm land conglomerate are recreational land, and mineral and extractive use land.

For most people there seems to be a basic need for at least occasional contact with nature via hunting, fishing, camping, picnicing, athletics and various other participant outdoor recreational activities. With a sparse and largely rural population, such recreational uses of land result in no problem; a limited amount of recreational use of land is supplementary to agricultural and forestry uses. However, as population has increased and has become more thickly concentrated, gratification of recreational needs has necessitated provision or reservation of land, especially for this use. Land allocated primarily to recreational use is thus a feature of modern urbanized society. The need for land so allocated has been only recently recognized and does not appear to have been met as yet. The 92,000 acres of parks and wildlife areas in Ohio (Table 4 derived from census data) are inadequate for current needs, and considerable expansion is to be expected in the future. However, the present acreage represents only about 4 percent of non-farm land, and thus is of relatively small importance in the aggregate picture of land use.

Mineral and extractive use of land is of local importance as a source of coal, gravel, sand, limestone, sandstone, clay, oil, gas, etc. Except for coal, these uses ordinarily are confined to relatively small areas, where they do not constitute a serious problem either locally (except occasionally, by virtue of strategic location) or aggregatively. Coal, however, accounts for enough area that one must be cognizant of the problems involved. Underground mining, of course, has some
problems but from the standpoint of land use these are minor. Strip mining leads to problems which are not minor. The unique place of strip mining with respect to land as a resource is discussed in another section; the important element at this stage is the quantitative importance of the area which has been or will be claimed by strip mining.

The amount of land used by strip mining, or lost for other uses as a result of stripping, is affected by not only the extent of operation but also by other factors such as the potential reclamation of part of this land. This complexity makes it desirable to postpone consideration of strip mined land until a subsequent section where it will be handled in more detail. Let it suffice at this point to indicate that strip mining appears to be already a more important use of Ohio land than the total of parks, wildlife areas, military reservations and atomic energy sites combined, and therefore merits attention on a quantitative as well as a qualitative basis.

This analysis of the multitude of component uses to which non-farm land is put has not achieved a statement of the probable amount needed for each use in the future. A later section (Chapter IV) develops an "ideal" plan for the amount of land in each of these uses under certain assumed conditions; these uses when aggregated can be compared to the non-farm land projected for that period.

The aggregative pattern of land use in Ohio is the sum of the patterns for the component counties or economic areas. Ohio is not uniform geographically, agriculturally or economically; and the components of the total picture of land use may be grossly different
from the aggregative picture. Land use patterns of three areas of Ohio are studied in the three subsequent sections, with the objectives of discerning deviations from the aggregative pattern, determining factors in such deviation, and analyzing the implications for land use in the area and in the state.

Northwestern Ohio: Intensification of Agriculture

To exemplify the land use in northwestern Ohio, a nine-county area of relatively homogeneous soil and economic conditions has been selected. This area, also known as Economic Area 1 (Fig. 10), is comprised of nine counties: Defiance, Fulton, Henry, Ottawa, Paulding, Putnam, Sandusky, Van Wert and Wood. While northwestern Ohio includes some of the most productive agricultural soils of the state, it was the last part of the state to be settled. Location was, of course, a factor, since settlers came from the east and southeast; but the influence of the topography cannot be disregarded. This area was more repeatedly glaciated and more profoundly influenced by glaciation than other parts of Ohio. In pre-historic times the last of the glaciers, receding slowly, dammed up the drainage way to the northeast and added its melting ice to the waters of Lake Maumee, which covered most of what is now Area 1 for many years. Accumulation of water-borne silt and clay resulted in a highly fertile soil, but one with problems resulting from its slowness to drain and relative imperviousness to water. Ultimately the glacier receded and Lake Maumee vanished, or withdrew to the shorelines of Lake Erie; and the level fertile bed of Lake Maumee became land in the geographical as well as economic sense. However, the level topography, the slowness
of internal drainage and the humid climate resulted in much of the land becoming a swamp.

In the early days of settlement in Ohio, this area was called the Black Swamp and the insect and disease problem coupled with the agricultural hazards effectively discouraged settlement until drainage of the area was improved. Public, cooperative and private initiative poured their resources into development of a network of drainage ditches. Lowering of the water table reduced greatly both the hazards involved in raising crops and the risk of nuisance and disease from insects. Tile drainage has been added to supplement the open ditches. It is said that there has been more tile buried in this corner of Ohio than in all the rest of the country put together. Whether this claim is accurate or excessive, the importance of drainage is apparent.

Analysis of Land Use Patterns

Land use for these nine counties for 1900-1955 and projection of trends to 1975 and 2000 are presented in Table 8 and Figure 12. A gross analysis or "capsule" summary indicates that land in farms has declined very little. Both the area devoted to crops and the intensity of use of this land has increased and probably will increase further. Area 1 is an ideal example of simultaneous expansion of agriculture at both the intensive and extensive margins.
Table 8
Land Utilization in A Nine-County Area of Northwestern Ohio, by Census Periods, 1900-1955, and Projection of Trends to 1975 and 2000
(Thousands of acres)

<table>
<thead>
<tr>
<th>Land Use</th>
<th>1900</th>
<th>1910</th>
<th>1920</th>
<th>1930</th>
<th>1940</th>
<th>1950</th>
<th>1955</th>
<th>Projections²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1975</td>
</tr>
<tr>
<td>Cropland:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intertilled crops</td>
<td>588</td>
<td>597</td>
<td>538</td>
<td>572</td>
<td>776</td>
<td>823</td>
<td>941</td>
<td>985</td>
</tr>
<tr>
<td>Small grains</td>
<td>522</td>
<td>573</td>
<td>717</td>
<td>634</td>
<td>515</td>
<td>636</td>
<td>488</td>
<td>560</td>
</tr>
<tr>
<td>Meadow cut as hay</td>
<td>253</td>
<td>299</td>
<td>289</td>
<td>284</td>
<td>233</td>
<td>192</td>
<td>243</td>
<td>203</td>
</tr>
<tr>
<td>Total of crops specifiedb,c</td>
<td>1364</td>
<td>1468</td>
<td>1544</td>
<td>1490</td>
<td>1523</td>
<td>1652</td>
<td>1672</td>
<td>1748</td>
</tr>
<tr>
<td>Woodland in farms</td>
<td>NRd</td>
<td>279</td>
<td>226</td>
<td>200</td>
<td>168</td>
<td>193</td>
<td>173</td>
<td>122</td>
</tr>
<tr>
<td>Other land in farms</td>
<td>940</td>
<td>556</td>
<td>502</td>
<td>537</td>
<td>558</td>
<td>406</td>
<td>351</td>
<td>306</td>
</tr>
<tr>
<td>Total land in farmsc</td>
<td>2314</td>
<td>2303</td>
<td>2272</td>
<td>2226</td>
<td>2249</td>
<td>2251</td>
<td>2195</td>
<td>2177</td>
</tr>
<tr>
<td>Land not in farms</td>
<td>141</td>
<td>151</td>
<td>182</td>
<td>228</td>
<td>205</td>
<td>204</td>
<td>259</td>
<td>278</td>
</tr>
<tr>
<td>Total land areac,e</td>
<td>2454</td>
<td>2454</td>
<td>2454</td>
<td>2454</td>
<td>2454</td>
<td>2454</td>
<td>2454</td>
<td>2454</td>
</tr>
</tbody>
</table>

aProjections are based on a straight line trend fitted by least squares and on sums of projected components.

bNot to be construed as a total of all crops raised or total harvested cropland.

cComponents may not add to totals because of rounding.

dNR = Not reported in census data separately from other land in farms.

eFor uniformity the area as given in the 1920 census is used throughout.

Figure 12. Land Utilization in a Nine-County Area of Northwestern Ohio, 1900-1955, and Projection of Trends to 1975 and 2000

Source: Table 8
Acreage of intertilled crops remained fairly constant at slightly under 600,000 acres through 1930. Since that time, the increase in intertilled crops has been extremely rapid, with the 1955 acreage 64 percent greater than 1930. A straight line fitted to these data by the method of least squares shows as a trend value an increase of 6440 acres per year. The relative absence of change before 1930 makes this trend or average for the 55-year period the more striking. It will be recalled that the increase in the corresponding intertilled crop acreage for the entire state was 8800 acres (p. 58), which represented 0.2 percent per year increase. Nearly three-fourths of the total increase in intertilled crop acreage in the state is to be found in this one area, which has less than 10 percent of the total land area.

While some increase in total cropland has occurred, as will be discussed subsequently, the increase in acreage of intertilled crops since 1920 has been due largely to more intensive use of the available cropland. The proportion of intertilled crops in the total of crops specified in Table 8 is much greater in the latter part of the period. The first 4 census periods (1900, 1910, 1920 and 1930) show an average of 574,000 acres of intertilled crops, or 39 percent of the 1,466,000 acres used for all the crops specified. For the last 3 census periods (1940, 1950 and 1955), intertilled crops average 847,000 acres or 52 percent of the 1,616,000 acres used for all the specified crops.

\[ (\text{acreage of intertilled crops}) = 502,107 + 6440 \times; \text{origin at 1900, } X = 1 \text{ year}. \]
On an acre basis, inputs of labor as well as capital in the form of machinery and equipment, fertilizer, chemicals for insect and weed control, etc., are much greater for intertilled crops of corn and soybeans than for small grains or meadow. The extent of truck and cannery crops which locally account for part of the intertilled acreage is further evidence of the intensity of land use. This is a further increase in intensity on land which is already intensively used and which is already receiving more units of other resources than many other agricultural areas of the state. The ability of the land to "pay off" and economically justify such a level of input is documentation of the high use-capacity of the soils of Area 1.

The usual justification for or explanation of a rise in the intensive margin of cultivation is a rise in price (effective demand) for the products of agriculture, or a lowering of production costs. There has been no long-term trend toward increase in prices of agricultural products or decrease in production costs during the period covered by this study. Yet, the farmers are using land more intensively and seek to expand their area base at the same time. While any explanation of this phenomenon is likely to be an over simplification, it appears that intensification in the form of more intertilled crops can be largely explained by three factors: soybeans, fertilizer and machinery.

Soybeans had been raised primarily as a hay crop until about 1930. Since that time, culture of soybeans for beans has become more widespread both in Ohio and elsewhere. In 1928-32 the acreage of soybeans for beans in Ohio averaged 31,000 acres, which was about 3 percent of
For the 10-year period 1946-55, the Ohio acreage averaged 1,011,000 acres and in 1957 reached 1,421,000 acres. While this was only 7 percent of the U. S. crop, it was nearly 46 times the 1928-32 average acreage. Because some of the lake bed soils are slow to dry out in the spring, soybeans (a shorter season crop than corn) are well adapted and, at present, are firmly established as an important part of the agricultural economy of this area.

Fertilizer seems to have been responsible for part of the increase in intertilled crops. Its use has prevented a decline in yield of crops as the virgin fertility of the soil has become depleted over time. More important in this connection has been the discovery (or application of the knowledge) that moderate to heavy rates of fertilization, especially with nitrogenous fertilizers, can free the farmer from bondage to rotations which include a fairly high proportion of meadow crops. Corn in particular needs nitrogen; fixation of nitrogen by symbiotic bacteria in the roots of leguminous plants formerly was the only feasible scheme for adding nitrogen, and a rotation with clover or alfalfa preceding corn was virtually essential to successful corn production. Availability of chemical fertilizers, including nitrogen, at prices which made buying fertilizer cheaper than growing it, reduced the need for legumes in the cropping program and permitted expansion of the acreage of corn.


\[24\text{Agricultural Statistics: 1958, p. 133.}\]
Machinery also has been a factor in the increase in row crops. The row-crop tractor was introduced about this time. Mechanical power for cultivation, as well as for the other tasks for which tractors had already proven their worth, reduced the farmers' dependence on horses. Reduction in number of horses permitted replacement of pasture and hay used for horse feed with intertilled crops for cash sale. At about the same time, the mechanical corn picker was developed for use with tractor power. The resulting mechanization of the corn harvest increased the acreage of corn which one man or one crew could handle. The development of the practical and dependable one-man combine had a similar effect on soybean harvest and relaxed previous restrictions on the area or proportion of soybeans in the cropping program. The necessity of diversifying crops in order to distribute labor requirements and keep seasonal requirements within bounds was thereby lessened, and as a direct consequence, cropping programs were made more intensive with more emphasis on intertilled crops.

Other changes in the cropping pattern have been less striking than the increase in intertilled crops. The acreage of small grains has shown wide variation, but very little trend is evident. The high point (717,000 acres) in 1920 probably was related to the "Wheat will win the war" campaign. A similar campaign may have caused the upturn in 1950. The 1955 area (488,000 acres) was only two-thirds of the 1920 acreage.

\[ Y = 598,695 - 516X; \text{ origin at 1950, } X = 1 \text{ year.} \]
peak. In view of the variability of acreage and relative absence of trend it may be concluded that while some small grain acreage is probably supplementary to intertilled crops, its importance in the cropping pattern of the area depends upon its profitability.

Acreage of meadow harvested as hay in northwestern Ohio has declined with some regularity except for the extreme periods of this series. It is important to note that this figure is not a measure of meadow production or of land on which legume or grass crops were seeded, but only of that fraction from which hay was harvested. Meadow crops harvested by livestock as pasture are not included in this category, nor are legume crops which are grown for soil improvement or green manure purposes. Thus, an important share of the uses of rotated meadow are not recorded and the acreage devoted to these uses is unknown. However, the trend in acreage of hay and circumstantial evidence both favor the belief that less land is devoted to meadows and soil building crops than formerly. The evidence is supplied by the decreasing agronomic dependence on meadows and elimination of engineering dependence on hay as fuel for field operations. The economy of the entire area seems to be evolving as a cash-crop agriculture, as opposed to a livestock-oriented agriculture.

The reduction in acreage of the "other land" or catch-all category seems to be in agreement with the foregoing statements regarding livestock. The farm roads, lanes, ditches and buildings components of

\[ Y (\text{acreage of hay}) = 290,224 - 1,164X; \text{ origin at } 1900, X = 1 \text{ year.} \]
this category are unlikely to diminish much, so the very evident trend
toward reduction in acreage of other land, particularly since 1940,
must have come primarily from pasture land and/or elimination of fence
rows. All of these changes appear to go hand in hand with the reduc-
tion in emphasis on livestock in the whole area.

In 1900 the census did not report woodland in farms separately
from other land in farms. In 1910 woodland in farms in this area
amounted to 12 percent of land in farms. Since then, over 100,000
acres have been cleared, and by 1955, woodland accounted for less than
8 percent of land in farms. The trend is obviously in the direction
of elimination of all forests in farms where the land is suitable for
cropland.

The statistical series on which the trend is based shows a 15
percent increase in woodland between 1940 and 1950 -- an increase
which it is difficult to accept or visualize under the agronomic and
economic conditions existing at this time and place. If the increase,
or even a part of the increase, of 1950 over 1940 was due to a change
in definition (and this appears to have been the case), the the trend
toward elimination of farm woodlots is faster than previously shown.
Virtually complete elimination of the farm woodlots in this area on
land suited to use for crops thus appears to be possible by the year
2000.

\[ Y \text{ (woodland in farms)} = 276,986 - 2,063X; \text{ origin at 1900, } X = 1 \text{ year.} \]
Clearing the woods, plowing up the pasture and otherwise increasing the amount of cropland at the expense of other uses of land in the same farm may be considered as either intensification or extensification. Certainly the application of other resources per unit area of land is more intensive for cropland. From the standpoint of society, all uses of land may be viewed as a continuum; in this sense woodland, pasture and cropland are merely increasingly intensive stages in biological use of land. Thus, shifting woodland to pasture or pasture to cropland use may be regarded as intensification.

However, this viewpoint is not typical of the attitudes of farmers; it is much more common for them to distinguish between the agriculturally useful cropland and the relatively useless woodland. It is in the latter sense that clearing of woodland on farms in Area 1, and thereby permitting its use as cropland, constitutes a change in land use at the extensive margin, since the extent of cropland is increased. Insofar as the best land was cleared first, and to whatever extent that land still uncleared is of lower potential productivity, clearing the remaining woodland for use as cropland is evidence of a shift in the extensive margin of land use.

The costs of bringing woodland into cultivation are considerable. Removal of trees, including stumps and roots, requires either heavy machinery or much hand labor, or some combination of both. Drainage is commonly needed; the installation of complete tile drainage systems nowadays costs, in most cases, well over $100 per acre. The sum of clearing costs and drainage costs is in many cases as much as or more than the cost of comparable farm land in the community. Where these
price relationships hold, there would appear to be but little incentive to change land use. Nevertheless, census data indicate that the change is taking place.

An explanation of this seeming paradox can be derived from the economic principles of proportionality, opportunity cost, and fixed costs. The task of clearing the land may be spread over a period of many years. Labor involved may be family labor and thus a fixed cost. A gradual upgrading of the quality of pasturage obtained from the woodlot may be finally culminated in a shift to cropland. When the stumps and roots finally decay to where they offer little obstacle and the land is plowed, the change is complete statistically even though drainage may be needed before crop production reaches a high order of success. The relationship between the incremental costs and the returns expected from that increment may dictate that the farmer stop anywhere along the way. As viewed by the farmer in each production period, the returns from the woodlot as pasture may be more important—because more tangible—than the possible future returns from timber.

There are, of course, other reasons for clearing woodland. Larger fields or larger volume of farm business, may offer economies of scale. In some cases the nature of the woods and of the soil may be such that a new farm or an addition to an existing farm can be carved out of woodland at a cost less than the opportunity price of comparable resources.

Projection of trends and analysis of factors indicates that all of the land in Area 1 which has the inherent capability for use as cropland will be so utilized. Such a prediction would naturally be negated by preemption of the land for non-farm uses.
Land in farms has shown a slight decline since 1900 in Area 1, the trend value\textsuperscript{28} of this decline being less than 0.1 percent. While this area is predominately agricultural, it does have a sprinkling of towns and cities of moderate size which have the usual tendency to sprawl outward, establishing motels, used car lots, drive-in theaters, etc. on land previously used for farming. In addition, the Ohio turnpike and widening of certain other highways have made some inroads on the agricultural land. Manufacturing, while not a major user of land in these counties, has had some influence on agriculture as evidenced by the increase in part-time farming.

Viewed in perspective, the supersession of agricultural land by other uses is not great in Area 1. If it were no greater elsewhere than it is in this area, there would be less reason for concern about our future supply of land for agriculture.

Comparison of Projections

Comparison of land utilization in 1975 as projected by trends from census data and as projected by the Conservation Needs Inventory Committee is done for Area 1 in a manner similar to what was done for the state as a whole.

Table 9 presents the most recent inventories and the projections for 1975. Here, as before, the low degree of comparability of the classes adds to the problem of interpretation.

\textsuperscript{28}Y (land on farms) = 2,311,093 - 1.793X; origin at 1900, \( X = 1 \) year.
Table 9

Inventory, Projection and Changes in Land Utilization,
A Nine-County Area in Northwestern Ohio

A. Based on census data (thousands of acres)

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Inventory 1955</th>
<th>Projection 1975</th>
<th>Change</th>
<th>Amount</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total of Crops Specified</td>
<td>1672</td>
<td>1748</td>
<td>+76</td>
<td>+ 4.5%</td>
<td></td>
</tr>
<tr>
<td>Woodland in Farms</td>
<td>173</td>
<td>122</td>
<td>-51</td>
<td>-29.5%</td>
<td></td>
</tr>
<tr>
<td>Other Land in Farms</td>
<td>351</td>
<td>306</td>
<td>-45</td>
<td>-12.8%</td>
<td></td>
</tr>
<tr>
<td>Total Land in Farms</td>
<td>2195</td>
<td>2177</td>
<td>-18</td>
<td>- 9.8%</td>
<td></td>
</tr>
<tr>
<td>Land Not in Farms</td>
<td>259</td>
<td>278</td>
<td>+19</td>
<td>+ 7.3%</td>
<td></td>
</tr>
</tbody>
</table>

Source: Table 8

B. Based on Conservation Needs Inventory data

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Inventory 1955</th>
<th>Projection 1975</th>
<th>Change</th>
<th>Amount</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cropland and Rotated Pasture</td>
<td>1911</td>
<td>1913</td>
<td>+ 2</td>
<td>+ 0.1%</td>
<td></td>
</tr>
<tr>
<td>Woodland</td>
<td>182</td>
<td>150</td>
<td>-32</td>
<td>-17.6%</td>
<td></td>
</tr>
<tr>
<td>Pasture Land</td>
<td>60</td>
<td>47</td>
<td>-13</td>
<td>-21.7%</td>
<td></td>
</tr>
<tr>
<td>Other Land</td>
<td>139</td>
<td>121</td>
<td>-18</td>
<td>-12.9%</td>
<td></td>
</tr>
<tr>
<td>Inventory Acreage</td>
<td>2291</td>
<td>2231</td>
<td>-60</td>
<td>- 2.6%</td>
<td></td>
</tr>
<tr>
<td>Excluded Area</td>
<td>163</td>
<td>223</td>
<td>+60</td>
<td>+37.8%</td>
<td></td>
</tr>
</tbody>
</table>

Source: Preliminary data, Ohio Committee for National Inventory of Soil and Water Conservation Needs.
Area of land in cropland and rotation pasture (Conservation Needs data) increases only nominally while the projection based on census data indicates considerable increase in cropland. The census projection indicates a substantial decrease in woodland and other land in farms; some of this land is upgraded to cropland, increasing the area in that use. The C. N. projection indicates far less decrease in woodland, pasture land and other land; most of what is lost here becomes "excluded area," which is urban and built-up land, inundated areas and federally owned land. While the direction of change is the same for those classes which are (approximately) comparable, the magnitude of change differs sufficiently to indicate somewhat different emphasis by the two projections. This is no doubt due to the historical bias of the projection from census data. In the past half century, Area 1 has intensified its agriculture and has resisted urbanization. The projection continues these trends and indicates further intensification of agriculture. The C. N. projection appears to indicate supersession of agricultural uses by urban uses, but relative to the C. N. projection for the state the amount of land lost to urbanization is not excessive, being 2.6 percent for Area 1 compared to 5.9 percent for the state as a whole.

The general agreement in direction of change projected by these two methods underscores the conclusions of the foregoing analysis, which may be summarized as follows: In Area 1, land not in farms will increase somewhat by 1975, with a corresponding decrease in amount of farm land. This decrease will not reduce cropland; rather, significant
 reductions in woodland and other land will permit a small increase in cropland acreage.

**Southeastern Ohio: Retirement of Farmland**

To represent the changes and the problems in land use in southeastern Ohio, a ten-county area has been selected. Shown on the map (Figure 10) as Area 10, this area includes: Athens, Gallia, Hocking, Jackson, Lawrence, Meigs, Pike, Scioto, Vinton, and Washington counties. Land area totals 3.1 million acres or about 12 percent of the area of Ohio, but this sample is representative of perhaps 7 million acres in Ohio and even greater acreages in Pennsylvania, West Virginia, Kentucky and elsewhere. This area, broadly speaking, comprises weathered foothills on the northwestern fringes of the Appalachian Highlands. Glaciation, so important in shaping the physiography and the destiny of other areas of Ohio, affected southeastern Ohio only indirectly through influence on the route or direction of flow of the rivers.

**Factors in Supermarginality or Submarginality of the Hill Country**

This part of Ohio was the locale of the first settlement in the Northwest Territory. With the settlers coming from the East and Southeast and with water as their primary transportation medium, other locations were less feasible. The first white men to make their homes here were little more than transients, whose subsistence was based on a semi-nomadic hunting and fishing culture. Later, settlers literally carved their cabins and their farms from the forests and cleared the trees from fields to permit raising of crops. At that time, self-
sufficiency was an essential characteristic of agriculture because the means of transporting either supplies from or products to markets did not exist. Labor requirements were high in agriculture at that time, for animal power was used for only a few operations and simple hand tools sufficed for the balance. Under this combination of circumstances, the irregular topography of southeastern Ohio not only was no handicap but was a real advantage to the settler.

As technology evolved in agriculture, permitting more and more substitution of capital (equipment of various types) for labor, the advantage shifted. The larger and more complex machinery was better suited to level topography and larger fields. Eventual development of mechanical sources of power largely overcame the problem of heavy draft of implements in the level soils. These and other innovations benefitted level-land areas so that costs of production of agricultural commodities were lowered. Less cost-reducing effect was felt in the hill country. With prices of agricultural products being established competitively, the profits from hill farming were competed away. Most hill farms were definitely supermarginal at the time they were settled and cleared; value of output on such farms exceeded the total costs of production. However, with the reduction in prices relative to their costs of production, total costs could no longer be met by many farms which thus became submarginal.

As long as variable costs of production are covered or exceeded by the value of output, these submarginal farms should in theory and do in fact continue production. Total costs of production include some resources whose period of production (useful life before replacement)
is quite long. A well-built barn may last a century. A supply of labor may be fixed for the lifetime of the farmer, if he refuses to recognize his opportunity costs at alternative employment; the useful or productive life of such labor may be as much as 50 to 60 years. The productivity of the soil may be maintained for many years with little or no expense if reasonable care is exercised in its use. Other resources may also be fixed for long periods of time. The variable costs which must be met in order to continue production may therefore be so low that even at low prices, farmers are justified in continuation of their operations. The intuitive analysis of the farmer and the objective analysis of the economist arrive at the same conclusion in this case.

Farmers and economists may also reach the same conclusions with respect to termination of operations. A business which barely covers variable costs of operation may be unable to cope with additions to variable costs when resources require replacement. Eventually the barn collapses with age, the worn-out machinery can no longer be patched up, the nutrient element content of the soil is lowered to where crop yields decline, the labor supplied by the operator is diminished because of his age, or in some other form the fixed costs at last become variable. The submarginal farm, being unable to bear the cost of replacing the barn, machinery or labor or of reclaiming the soil, is forced to terminate operations.

When this happens on farms in the hill country of Ohio, and farming operations cease, the forces of nature move in to reclothe the hills with forest cover. Few such farms are completely abandoned; the house is likely to be used as long as it is habitable. But as a
producing entity in agriculture, the farm no longer exists. The land is still there; part or even all of the buildings may be there. But by the census definition or any other reasonable definition, the place is no longer a farm. It may be a managed forest, or it may be managed only by the forces of nature. Within a few years, the fence rows and the sprouts in the pasture will have expanded their area to the 10 percent cover defined as a forest. Non-farm woodland is thereby increased. Farm woodland is but little affected, for those farms on which acreage of woodland increases soon are excluded from the class of farms. Acreage of cropland, particularly that used for intertilled crops, declines rapidly. The types of farming for which the land is best adapted or for which it is least disadvantaged may increase relatively or even absolutely. On the whole, these changes in intensity of land use constitute adjustment by society in line with principles or equimarginality of returns, so that returns to the resources of land, labor, or capital will be equal in southeastern Ohio to the returns from alternative opportunities elsewhere.

Evolving Land Use Patterns in Southeastern Ohio

The foregoing picture of the process of land use recession to a lower intensity is painted with a broad brush. Some quantification is desirable to support the generalities in this description.

In the ten-county area, considered here to be representative of southeastern Ohio, land use has changed since 1900 in a pattern quite in accord with that indicated by theory (Table 10 and Figure 13).
The acreage of intertilled crops in Area 10 declined from 291 thousand acres in 1900 to 144 thousand acres in 1955, a decline of about one-half.\(^{29}\) In 1900, intertilled crops made up 11 percent of the land in farms, while in 1955, these crops accounted for 8 percent of farm area. Row crops thus are shown to have a less important place in the agriculture of Area 10 now than they did in 1900. This indicates a shift toward a less intensive or perhaps more conservation-oriented type of farming than was previously practiced. The contrast between Area 10 and Area 1 in northwestern Ohio is noteworthy; as previously indicated (p. 83), the agriculture of Area 1 is increasingly oriented to intertilled crops.

The decline in small grain acreage has been even greater than that of intertilled crops in Area 10. From a position on nearly equal footing, acreage-wise, with intertilled crops, small grain acreage declined nearly 80 percent by 1955, and as of this period represented only about 3 percent of land in farms.\(^{30}\) In the discussion of small grain acreage in Ohio (p. 59), the worsening competitive position of small grain production in Ohio was brought out. This disadvantage has been even more important for Area 10. The decline has been continuous since 1900 except for temporary checks in 1920 and 1950 traceable to the effects of World War I and the Korean War. The inefficiency of

\(^{29}\) Trend value for acreage of intertilled crops in Area 10: \(Y = 298,709 - 2,790 X;\) origin at 1900, \(X = 1\) year.

\(^{30}\) Trend value for acreage of small grains in Area 10: \(Y = 207,176 - 3,133 X;\) origin at 1900, \(X = 1\) year.
small grain production in Area 10 thus caused a decline in acreage there before the gasoline tractor and the combine became factors. Even with the binder-thresher system of harvesting, small fields and sloping topography constituted sufficient disadvantages in small grain production that profits from this use of land were unsatisfactory and adjustments were being made.

Hay in Area 10 has declined in acreage but increased in relative importance. Acreage of meadow cut as hay declined by about one-sixth from 1900 to 1955.\(^{31}\) Expressed as a percentage of land in farms, acreage of hay has increased from 7.7 percent in 1900 to 9.8 percent in 1955, so that hay is roughly one-fourth more important in the agriculture of the area than it was at the turn of the century.

The continuation of farming in this area on an economic basis has had two obstacles to overcome: shifting to types of farming adapted to the resources, and maintaining the soil resources. Hay and meadow crops help overcome both hurdles, for erosion of soil is much less of a problem where meadows make up a major portion of the crops raised and livestock farming—with emphasis on species which are roughage consumers—is the type of farming which seems to be best adapted or least disadvantageous in Area 10.

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\(^{31}\) Trend value for acreage of meadow cut as hay: \( Y = 214,457 - 879 \times; \) origin at 1900, \( X = 1 \) year.
Table 10
Land Utilization in a Ten-County Area of Southeastern Ohio, by Census Periods 1900-1955, and Projection of Trends to 1975 and 2000
(Thousands of acres)

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cropland</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intertilled Crops</td>
<td>291</td>
<td>282</td>
<td>247</td>
<td>202</td>
<td>194</td>
<td>159</td>
<td>144</td>
<td>89</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Small Grains</td>
<td>253</td>
<td>130</td>
<td>181</td>
<td>77</td>
<td>61</td>
<td>68</td>
<td>52</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Meadow Cut as Hay</td>
<td>203</td>
<td>221</td>
<td>201</td>
<td>187</td>
<td>169</td>
<td>166</td>
<td>174</td>
<td>149</td>
<td>127</td>
<td></td>
</tr>
<tr>
<td>Total of Crops Specified</td>
<td>747</td>
<td>634</td>
<td>630</td>
<td>465</td>
<td>423</td>
<td>393</td>
<td>370</td>
<td>238</td>
<td>146</td>
<td></td>
</tr>
<tr>
<td><strong>Woodland in Farms</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NR</td>
<td>598</td>
<td>598</td>
<td>541</td>
<td>459</td>
<td>599</td>
<td>601</td>
<td>553</td>
<td>545</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Other Land in Farms</strong></td>
<td>1,226</td>
<td>1,354</td>
<td>1,248</td>
<td>1,155</td>
<td>1,246</td>
<td>979</td>
<td>803</td>
<td>737</td>
<td>442</td>
<td></td>
</tr>
<tr>
<td>Total Land in Farms</td>
<td>2,644</td>
<td>2,586</td>
<td>2,476</td>
<td>2,161</td>
<td>2,128</td>
<td>1,971</td>
<td>1,774</td>
<td>1,528</td>
<td>1,133</td>
<td></td>
</tr>
<tr>
<td><strong>Land Not in Farms</strong></td>
<td>422</td>
<td>490</td>
<td>599</td>
<td>915</td>
<td>948</td>
<td>1,105</td>
<td>1,302</td>
<td>1,548</td>
<td>1,943</td>
<td></td>
</tr>
<tr>
<td>Total Land Acres</td>
<td>3,076</td>
<td>3,076</td>
<td>3,076</td>
<td>3,076</td>
<td>3,076</td>
<td>3,076</td>
<td>3,076</td>
<td>3,076</td>
<td>3,076</td>
<td></td>
</tr>
</tbody>
</table>

*Projections are based on a straight line trend fitted by least squares and on sums of projected components.

Not to be construed as a total of all crops raised or total harvested cropland.

Components may not add to totals because of rounding.

NR = Not reported in census data separately from other land in farms.

For uniformity the area as given in the 1920 census is used throughout.

Source: Census of Agriculture: 1900 through 1954.
Figure 13. Land Utilization in a Ten-County Area of Southeastern Ohio, 1900-1955, and Projection of Trends to 1975 and 2000

Million Acres

Source: Table 10
The total acreage of the crops specified has been less at each succeeding census period. Projection of trends in acreage suggests that by about the turn of the next century no more of these crops will be raised in Area 10. While this conclusion is not substantiated by logic or observation, it serves to emphasize the rate at which acreage of these crops has declined during this period.

**Land Use and Land Capability**

Examination of the graphic presentation of these data (Fig. 13) gives a visual impression of a tendency for the total of specified crops to "bottom out" or to decline at a reduced rate. Certainly the decline since 1930 has been slower than for the period 1900-1930. The rate of acreage reduction since 1930 has been nearly constant, but a sound, logical case can be built for expectation of slower decline in the future. With exogenous or urban influence at a minimum in the hill country, the land area used for crops should seek an equilibrium level, and might be expected to decline more slowly as it approached such a level. Examination of a soils inventory reveals a possible asymptote for such a leveling-off.

The land capability classes as established and used by the Soil Conservation Service designate the use capacity of land for agricultural or forestry purposes. Only a brief delimitation of these capability classes is given here; more detailed description is included in Appendix A. Land of capability Class I can be farmed intensively with practically no restrictions. Land of capability Classes II and III is adapted for raising crops but with restrictions on the intensity of
cropping and the need for moderate (on Class II) or intensive (on Class III) conservation treatment which may include rotations, contour and/or strip cropping, tile and surface drainage, application of lime and fertilizer, etc. Class IV is adapted to perennial vegetation and should be cultivated only infrequently. Classes V through VII should have no cultivation but are adapted to use as pasture, permanent hayfields, woodland, etc. Class VIII is essentially waste land with no economic use.

Land of capability Classes I, II and III may be considered as suitable for regular cultivation, assuming that proper precautions are taken and adequate conservation measures used. In Area 10 in these three classes there are slightly over one million acres of land currently (1958) in biological use. This area corresponds to the theoretical concept of the physical supply of land suitable for regular cultivation. The concept of economic supply corresponds to the acreage of this land used for crops of all sorts. Total cropland in Area 10 for 1955 was 568,000 acres. These data suggest that cropland in this area might well expand rather than contract farther, for the forests could be cleared and the pastures plowed up to permit expansion of cropland to one million acres.

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33 Census of Agriculture: 1954, Vol. I, Part 3, pp. 44-51. The total of specified crops (Table 10) cannot be used here because it does not include rotation pasture, miscellaneous crops, orchards and small fruits, and cropland not harvested.
Because of the dissected topography of southeastern Ohio, the soil types and land capability classes are intermingled to a greater degree than in more level areas. Small tracts or patches of land well suited to use as cropland lie amid encircling tracts which are suitable only for less intensive uses. The small size and scattered location of these patches preclude their economic use except in the same manner as the land around them, under currently accepted techniques and methods of farming. Moreover, it does not seem likely with the current low level of profit in agricultural production that much land of Class III will be cleared from woodland for utilization as cropland. Similarly, little clearing of forest is likely to be done even on land of capability I and II in an area where agriculture generally is on the decline. Under these physical, economic and institutional conditions, virtually no clearing of land will be done in Area 10 at current cost-price relationships. Therefore the ultimate or equilibrium acreage of crops may be fixed at the total acreage of land of capability Classes I, II and III currently in cropland or pasture. There are about 641,000 acres of such land in Area 10; current cropland acreage at 568,000 is already below this equilibrium level. This has occurred because some land of capability Classes I, II and III is being used for pasture and woodland, while some land of Class IV, V, VI and VII is being used as cropland. Some readjustment is taking place, partly because land of Class V or poorer cannot economically be maintained as cropland because of erosion and other problems.

Therefore, while the projection of trends in land for crops in Area 10 indicates the demise of arable agriculture in Area 10 by the
year 2000, a projection of cropland at approximately its present acreage seems more reasonable.

Woodland in farms in Area 10 has varied only slightly since it was first inventoried in 1910. The trend computed from the census data shows a slight decline but it is negligible. The bulk of the variation from one census period to the next appears to have arisen from differences in definitions of woods and of farms.

Woodland in farms must necessarily be a part of a tract which itself qualifies as a farm. A farm in the process of being retired, with a minimum of crops raised, may increase acreage of woodland in farms by virtue of pastures and even cropland growing up in brush and trees. But when production ceases altogether and the farm is no longer classified as such, woodland in farms is reduced by not only the recent increments but also the original forest area. In view of the changing composition of the woodland in farms, attempts to analyze this composition are not particularly fruitful.

The non-farm woodland is the segment of land use in Area 10 which needs to be analyzed. But analysis based on census data is impossible; there is no census data on non-farm woodland. Other sources are at best inadequate, but are presented to indicate the nature of the problem.

\[ Y \text{ (acreage of woodland in farms)} = 577,120 - 325X; \text{ origin at 1900; } X = 1 \text{ year.} \]
Inventories of Ohio's forests have been made at various times. Three inventories are shown in Table 11 made by the Ohio Forest Survey in 1939-1942 (published by Ohio Agricultural Experiment Station), by the Central States Forest Experiment Station (U. S. D. A.) in 1952 and by the Conservation Needs Inventory Committee in 1958. Unfortunately, these three inventories are not comparable, and no adequate basis exists for adjusting either series to insure comparability. Evidence of their non-comparability lies in the figures themselves: for the ten counties the acreage of woodland is indicated as increasing from 1.2 million to 1.6 million in 10 years, then decreasing to 1.5 million in 6 years. Assuming for the moment that all of the land not in farms in this ten-county area is forest, the comparable figures from census data (woodland in farms, plus all non-farm land) are 1.4 million (1940), 1.7 million (1950) and 1.9 million acres (1955) for the three census periods nearest the forest inventory dates. While these aggregations are known to be in error because they ignore urban, industrial and other uses of non-farm land, they deviate from reasonable figures and observed trends by a smaller margin than do the independent inventories.

35 Kenneth L. Quigley, Research Forester of the Central States Forest Experiment Station, suggests in "Who Owns Ohio's Forests?" (Ohio Conservation Bulletin, December, 1953, p. 16) that the state-wide increase of 47 percent indicated between the 1942 and 1952 surveys could be attributed one-third to actual increase in woodland, one-third to change in definitions or standards for forests, and one-third to increased accuracy of inventory. However, the same proportions cannot be applied to each of the sub-areas of the state.
Table 11
Woodland and Forest Area in Ten Counties in Southeastern Ohio as Reported by Three Independent Inventories, 1942, 1952 and 1958

(Thousands of acres)

<table>
<thead>
<tr>
<th>County</th>
<th>Ohio Forest Survey 1942</th>
<th>Central States Forest Exp. Station 1952</th>
<th>Conservation Needs Committee 1958</th>
</tr>
</thead>
<tbody>
<tr>
<td>Athens</td>
<td>116</td>
<td>138</td>
<td>138</td>
</tr>
<tr>
<td>Gallia</td>
<td>77</td>
<td>130</td>
<td>125</td>
</tr>
<tr>
<td>Hocking</td>
<td>128</td>
<td>151</td>
<td>127</td>
</tr>
<tr>
<td>Jackson</td>
<td>106</td>
<td>124</td>
<td>124</td>
</tr>
<tr>
<td>Lawrence</td>
<td>116</td>
<td>184</td>
<td>151</td>
</tr>
<tr>
<td>Meigs</td>
<td>71</td>
<td>132</td>
<td>127</td>
</tr>
<tr>
<td>Pike</td>
<td>119</td>
<td>161</td>
<td>155</td>
</tr>
<tr>
<td>Scioto</td>
<td>217</td>
<td>237</td>
<td>241</td>
</tr>
<tr>
<td>Vinton</td>
<td>156</td>
<td>179</td>
<td>167</td>
</tr>
<tr>
<td>Washington</td>
<td>101</td>
<td>192</td>
<td>185</td>
</tr>
<tr>
<td>Total a</td>
<td>1,207</td>
<td>1,628</td>
<td>1,540</td>
</tr>
</tbody>
</table>

a Both farm and non-farm.


Preliminary data of the Ohio Committee for the National Inventory of Soil and Water Conservation Needs.
It is evident that the future area of forestry and woodland in Area 10 cannot be determined by a projection from non-comparable series of data. Perhaps the potential of the land itself may furnish a clue or insight to prospects for forestry as a use of land in this section of Ohio.

Land of capability classes V, VI and VII is adapted to permanent vegetation. Classes VI and VII are best adapted to woodland. Class V is adapted to either pasture or forest, but the inventory reveals no Class V land in this area. The land adapted to woodland, and thus the eventual or equilibrium acreage of woodland in this ten-county area, is therefore the total of Classes VI and VII, or 1.2 million acres.

Table 12
Land Suited to Forestry in Ten Counties of Southeastern Ohio, 1958
(Capability Classes VI and VII and Currently Used as Cropland, Pasture or Woodland)

<table>
<thead>
<tr>
<th>County</th>
<th>Capability Class</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>VI</td>
<td>VII</td>
</tr>
<tr>
<td>Athens</td>
<td>40</td>
<td>65</td>
</tr>
<tr>
<td>Gallia</td>
<td>47</td>
<td>45</td>
</tr>
<tr>
<td>Hocking</td>
<td>30</td>
<td>48</td>
</tr>
<tr>
<td>Jackson</td>
<td>36</td>
<td>36</td>
</tr>
<tr>
<td>Lawrence</td>
<td>54</td>
<td>89</td>
</tr>
<tr>
<td>Meigs</td>
<td>20</td>
<td>78</td>
</tr>
<tr>
<td>Pike</td>
<td>35</td>
<td>85</td>
</tr>
<tr>
<td>Scioto</td>
<td>79</td>
<td>121</td>
</tr>
<tr>
<td>Vinton</td>
<td>46</td>
<td>65</td>
</tr>
<tr>
<td>Washington</td>
<td>72</td>
<td>108</td>
</tr>
<tr>
<td>Total</td>
<td>459</td>
<td>740</td>
</tr>
</tbody>
</table>

Source: Preliminary data, Ohio Committee for the National Soil and Water Conservation Needs Inventory.

36 The concept of capability classes and their characteristics are also presented on page 28 and Appendix A.
The woodland area of this section of Ohio in 1942 (Table 11) was almost identical with the equilibrium acreage (Table 12). Yet woodland area is expanding; the 1958 inventory indicates some 28 percent more woodland than the equilibrium acreage. Part of this deviation is in the computation of figures in Table 12; "other land" was excluded although part of it may have forest cover. Another part may be explained by the topography and the intermingling of soil types. Small areas of land of capability Class III or IV surrounded by Class II land are likely to be farmed in a manner befitting Class II, regardless of the consequences for the eventual productivity of the small tracts. Not all of the deviation from an ideal pattern can be explained for more land has reverted to forest cover than this analysis shows to have been desirable or necessary.

When these farms became submarginal, the general farming pattern was replaced not with a more extensive agriculture but with forestry. The land could not support arable agriculture, but the kind of agriculture which it could support and to which it was suited was not given a chance. Some of this land could be operated economically in large units (500 acres or more) under a system of farming emphasizing

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37 The following definition was a part of instructions given to the Conservation Needs Inventory Committee: "Other land: Farmsteads and idle (as formerly mapped on the soil survey) wildlife areas and other areas not classified into cropland, pasture and range, forest and woodland, and built-up and urban areas." U.S. Department of Agriculture, "Policy and Procedure for Development of National Inventory of Soil and Water Conservation Needs" Washington: U.S. Department of Agriculture, 1957, p. 11.
beef cattle or other similarly adapted livestock. However, the small size of farms in this area and the unwillingness of owners to sell their farms for prices justified by the agricultural productivity of the land effectively prevents consolidation into economic units. Several factors are involved in the unwillingness of owners to sell. The residence value of the buildings may be capitalized at a rate which disregards the short remaining life or the lack of advantages as homesites. Subsidies such as state aid to schools or federal farm programs may be capitalized into the reservation price. Speculation, too, can hardly be disregarded. Coal, oil and gas have been important in certain areas and the possibility—however remote—of profits from mineral rights is sufficient inducement to keep much of this land off the market except at prices not justified by either agricultural or mineral productivity. Increase in the value of land has long been a part of the American folklore, and this myth is really true as long as enough people believe it to bid the price of land higher and ever higher. For these and other reasons, little land is sold at prices at which extensive agriculture has a chance for success.

If more land has been reforested than was desirable, it does not follow that the pendulum will swing back or that the acreage of woodland will eventually adjust to the "equilibrium" area indicated by soil capability. Once reforested, the land is likely to stay in forest use

38 Under "top grade" management, beef cattle can pay for a major soil improvement program in southeastern Ohio. See Robert H. Blosser, "Economics of Improving Hill Land for Beef Production," Research Bulletin 822 (Wooster: Ohio Agricultural Experiment Station, 1958).
unless or until economic relationships change considerably. It should, in theory, remain in its present use unless or until the alternative use shows prospects of paying for the change in use (in this case clearing) and also covering all costs of operation after the change over. Until such time as the demand for food increases sharply relative to supply, supercession of forestry by extensive agriculture in southeastern Ohio is neither probable nor desirable.

Comparison of Projections

To permit comparison of projections based on census data with the projections made by the Conservation Needs Committee, the necessary data are presented in Table 13. Poor comparability of the classes is, if anything, a worse problem for Area 10 than for the preceding cases because of the large acreage of non-farm woodland.

Both projections indicate a reduction in cropland, but the Conservation Needs projection indicates much the smaller decrease. Rotation pasture is included in the Conservation Needs category of cropland; this use of land might be expected to increase as forage-consuming livestock becomes more important. The Conservation Needs cropland figure may also reflect the point of view that the needed adjustment in cropland has already been made, while the total of crops specified (census) projects the continuation of a rate of change which has resulted in significant adjustment in the past.
Table 13

Inventory, Projection and Changes in Land Utilization in a Ten-County Area of Southeastern Ohio

(Thousands of acres)

A. Based on Census Data

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Inventory 1955</th>
<th>Projection 1975</th>
<th>Change Amount</th>
<th>Change Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total of crops specified</td>
<td>370</td>
<td>238</td>
<td>-132</td>
<td>-35.7%</td>
</tr>
<tr>
<td>Woodland in farms</td>
<td>601</td>
<td>553</td>
<td>-48</td>
<td>-8.0</td>
</tr>
<tr>
<td>Other land in farms</td>
<td>803</td>
<td>737</td>
<td>-66</td>
<td>-8.2</td>
</tr>
<tr>
<td>Total land in farms</td>
<td>1,774</td>
<td>1,528</td>
<td>-246</td>
<td>-13.9%</td>
</tr>
<tr>
<td>Land not in farms</td>
<td>1,302</td>
<td>1,548</td>
<td>+246</td>
<td>+18.9</td>
</tr>
</tbody>
</table>

Source: Table 10.

B. Based on Conservation Needs Inventory Data.

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Inventory 1958</th>
<th>Projection 1975</th>
<th>Change Amount</th>
<th>Change Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cropland and Rotated Pasture</td>
<td>513</td>
<td>479</td>
<td>-34</td>
<td>-6.6%</td>
</tr>
<tr>
<td>Woodland</td>
<td>1,540</td>
<td>1,646</td>
<td>+106</td>
<td>+6.9</td>
</tr>
<tr>
<td>Pasture land</td>
<td>491</td>
<td>409</td>
<td>-82</td>
<td>-16.7</td>
</tr>
<tr>
<td>Other land</td>
<td>293</td>
<td>235</td>
<td>-58</td>
<td>-19.8</td>
</tr>
<tr>
<td>Inventory Acreage</td>
<td>2,836</td>
<td>2,768</td>
<td>-68</td>
<td>-2.4%</td>
</tr>
<tr>
<td>Excluded area</td>
<td>239</td>
<td>307</td>
<td>+68</td>
<td>+28.5%</td>
</tr>
</tbody>
</table>

Source: Preliminary data, Ohio-Committee for The National Inventory of Soil and Water Conservation Needs.
Total woodland (CN) shows a sizeable increase. In view of the foregoing comparison of woodland area and land capability classes, indicating more forest acreage than there is land whose best use is forest, this prediction is somewhat surprising. Local pessimism regarding the returns from alternative uses, or local recognition of current trends toward reforestation, may have influenced the predictions of the future area of forest land.

Land not in farms (census) shows a large increase, about one-fourth million acres, but this will be made up mostly of non-farm woodland (retired submarginal farmland). The aggregation of cropland, pasture land and other land (CN data) indicates a decline of 174 thousand acres (-13.4 percent), while the aggregation of crops specified and other land (census data), a rather closely comparable group, indicates a decline of 198 thousand acres (-16.9 percent). This agreement not only in direction but also in the amount and percentage of change in land use reaffirms the broad and general conclusion that land use in the hill country of southeastern Ohio will continue to be characterized by retirement of submarginal farm land, with the bulk of this land becoming reforested.

Another cause of the increase in land not in farms in some parts of Ohio is the use of land for mineral or other extractive uses. In some counties of southeastern Ohio, strip mining of coal is claiming thousands of acres of land formerly used for farming and forestry. Production of biological crops—whether grain, livestock or forestry crops—is interrupted for varying periods by strip mining. While Area 10 is not the most important part of Ohio in terms of strip mining,
stripping has occurred and will continue to be important in southeastern Ohio. For this reason it is desirable to analyze and discuss some of the relationships and implications of strip mining.

**Mineral and Extractive Use of Land**

The uses of land which have been discussed up to this point have been oriented to land as a flow resource. Land as space or area, or as the recipient of precipitation and sunshine, can hardly be other than a flow resource. However, some land is also desired for its stock resources: the outstanding example of stock resources is coal, oil, and other mineral wealth under the surface of the earth.

In some cases the stock resources may be tapped, even completely exploited, and cause little or no interference with utilization of flow resources. Gas or oil wells interfere but little, once the drilling has been completed, with production of crops on the surface of the land. Underground mining of coal has little effect on surface forestry. In other cases, however, the use of the stock (sub-surface) resources severely restricts, alters or eliminates the use of flow (surface) resources for more than a temporary period.

The strip mining of coal is an example of the latter category. As commercially practiced in southeastern Ohio, the "overburden" of rock, soil, etc., which lies above the coal stratum is removed by mechanical devices, primarily draglines and power shovels, exposing the coal for easy removal. The overburden, which may be as much as 100 to 125 feet thick, becomes mixed and partly or largely inverted in the removal process and is left by the machines as "spoil" in banks or ridges.
Little leveling or grading of these banks or ridges is usually done. The resulting areas give the visual impression of complete and utter devastation. If this impression is accurate, the flow resource aspect of land may be completely written off where the stock resource (coal) is exploited.

A complete write-off, however, is not always necessary, for the visual impression of devastation is not infrequently overdrawn. Depending on several factors, the spoil banks can, in some cases, be reclaimed for biological uses within a relatively short period of time. Among the important factors in the time required are the size of particles in the conglomerate, the presence of calcareous materials, the absence or effective sealing off of minerals which if exposed result in toxic leachates, and enough grading or leveling to produce an accessible topography. Perhaps 70 to 75 percent of the spoil is of such geologic origin and nature that if properly handled it will support vegetation. This vegetation may include desirable grasses and legumes, yielding moderate to high quality and amount of pasture for livestock. It may include desirable species of trees, for production of Christmas trees, pulpwood, poles, and eventually lumber. Ponds and lakes of various sizes are feasible, and where acid wastes and leachate are avoided fish production is successful. Thus the stripped area need not in its entirety be subtracted from the usable

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39 This and other estimates were supplied by G. Orville Bates, field supervisor for the Division of Reclamation, Ohio Department of Natural Resources.
land resource area of the state; utilization of the stock resource need not altogether vitiate the flow resource.

On the other hand, some 5 to 10 percent of the spoil has a degree of acidity or toxicity such that plantings have proven unsuccessful, and early success is not envisioned. This proportion of the land would appear to be of little or no value after stripping, constituting a local "badlands" or a humid area desert. Even this land can be expected to ameliorate over time. Since soil building processes on similar parent material required geologic ages to produce the "virgin productivity" which explorers and pioneers encountered in this area, it should not be expected that the amelioration will be rapid. If generations or centuries are required to bring spoil banks to where they will support useful vegetation, their area cannot be completely overlooked in the formulation of a long-range land use plan. However, within the planning horizon utilized in this study, little or no value as a flow resource can be expected.

Production of bituminous coal has varied relatively little in the United States by five-year periods since World War I. Annual output has been around one-half billion tons recently. Ohio production has been more variable but since 1940 has averaged about 35 million tons annually. On the basis of past trends, there seems to be no reason for expecting coal use or production to decline, at least until

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40 Idem.

reserves are depleted. On the other hand, neither is there any basis in trends for expecting use of coal to increase in proportion to population. Other fossil fuels, and hydroelectric, solar and nuclear sources of energy will undoubtedly expand their contributions to society's annual energy supply. In view of the lack of trends in coal production it appears that these alternative sources will supply the bulk of society's incremental needs.

While total output of coal has remained stable, the methods of production used in mining coal have changed tremendously. Strip mining accounted for a negligible proportion of our national output prior to World War I, but its importance has grown rapidly and rather uniformly. At present something in excess of one-fourth of the nation's coal is mined by stripping.

Without a detailed or laborious analysis, it can reasonably be concluded from these data that the use of land for purposes of strip mining coal will continue at not less than its current rate.

Strip mining of coal had affected approximately 45,000 acres in Ohio prior to 1948. Since that time, an average of about 10,000 acres has been affected each year, of which about 18 percent is in Area 10. The area which strip mining has affected in Ohio now totals approximately 150,000 acres (Table 14). However, some of this land is "re-affected"—either stripped again for coal at a deeper level, or

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because of the method of measurement counted twice. Approximately one-half of the pre-1948 acreage has been re-affected, and some 20 percent of the 1948-1958 acreage represents double counting.\(^4\)

A study by the Division of Geological Survey of the Ohio Department of Natural Resources, conducted about 1958, indicated the proven and probable reserves in the more important beds of coal in Ohio which were recoverable by stripping (coal stratum 28 inches or thicker, and depth to coal stratum not more than 100 feet). A condensed summary of this information is presented in Table 14, which indicates total strippable reserves of over 400 thousand acres.

Projecting into the future the past rate of stripping, it appears that the 400 thousand acre backlog of coal reserves will have been exploited in 40 years, or by about the turn of the next century.

Of course, the other coal beds not included in the available data will increase the potential. Design and construction or even larger power shovels, capable of removing overburden of greater depth, will permit recovery of coal overlaid by more than the 100 foot depth used in the study referred to. On the other hand, the diseconomies of dwindling reserves and competition from other sources of fuel could reduce the rate of exploitation below the projected rate. Adjustment for re-affected or double-counted area effects a reduction in the total. These changes would bring about alteration of the degree but not of the nature of the problem: one-half million acres of spoil

\(^4\)Estimates supplied by G. Orville Bates.
banks. If, as previously discussed, 5 to 10 percent of the spoil banks are incapable of reclamation for forestry or higher uses, this area—some 50 thousand acres—will remain as land in the spatial sense only, a problem area without economic use.

Table 14
Strip Mined Land and Coal Reserves Subject to Strip Mining, Ohio, 1960

<table>
<thead>
<tr>
<th>Area stripped before 1948</th>
<th>45</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area stripped 1948-1959</td>
<td>110</td>
</tr>
</tbody>
</table>

Reserves of strip-mineral coal:

<table>
<thead>
<tr>
<th>Coal</th>
<th>Area (1000 acres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 5 Coal</td>
<td>185</td>
</tr>
<tr>
<td>No. 8 Coal</td>
<td>96</td>
</tr>
<tr>
<td>No. 8A Coal</td>
<td>20</td>
</tr>
<tr>
<td>No. 9 Coal</td>
<td>121</td>
</tr>
</tbody>
</table>

Total reserves subject to strip mining | 422

Total of realized or potential strip mined area\(^a\) | 577

\(^a\)Approximately one-sixth of this acreage is located in the counties comprising Area 10.


The foregoing discussion has considered strip mining as a problem of Ohio, particularly of southeastern Ohio, without specific county references. Strip mining is less common and less of a threat in Area 10 than in the counties north and northeast from Area 10, extending as
far north as Mahoning County and as far northwest as Wayne County. In terms of total area potentially usable for strip mining of coal, Mahoning, Jefferson, Harrison, Belmont and Noble counties face the greatest quantitative problem. Of the total acreage of potential and realized strip mined area in Ohio, about one-sixth is located in the counties comprising Area 10. Such exploitative use of resources, however, merits attention out of proportion to the area of land affected.

Northeastern Ohio: Urbanization

The land use situation in northeastern Ohio which is to be analyzed in this section is somewhat less typical of geographic area than was the case with the northwestern and southeastern areas. The land use situation here considered is typical of a stage of economic development, and the land resource for agricultural use is of secondary importance.

To represent this situation a group of five counties in northeastern Ohio has been selected. These counties—Cuyahoga, Lake, Summit, Stark and Mahoning—are contiguous, but do not form a compact block. Their arrangement is a rough semi-circle touching both Lake Erie and the Pennsylvania border. Their soil conditions are not homogeneous. While all of these counties are urbanized, the extent and intensity of urbanization differs both from county to county and within any given county. They are, in a sense, misfits and their assignment to any economic or agricultural area is subject to question on some grounds. The generalized soils map of Ohio (Figure 9) indicates that on the basis of soil characteristics, Stark and perhaps Summit counties should be grouped together with Wayne and Holmes, Mahoning and Cuyahoga should
be grouped with several other counties, and Lake should be in a
different group.

In this study, the primary basis for the separation of these five
counties from those surrounding is that basic similarity in land use
exists among these counties, which for this analysis is more important
than homogeneity of agronomic potential. This pattern of land use has
resulted from the urbanization of this area; similar patterns may be
expected in other areas where urbanization is the predominant
influence. The five-county area selected has pronounced urban charac-
teristics. In this area are the sixth largest city in the nation, the
world center of rubber manufacturing, and the nation's second largest
steel production center. Four of Ohio's nine Standard Metropolitan
Areas are within these five counties. Only about 5 percent of the land
area of the state lies within these five counties, but over 30 percent
of the people live there (see Table 15). What is more, the percent of
increase in population from 1950 to 1959 in this area was the same as
for the rest of the state, indicating that this area is maintaining the
lead. These counties lie astraddle of the east-west transportation
corridor, and it is felt in some quarters that the future industrial
growth of this area will exceed that of the rest of the state.

The growth of this area in manufacturing and commerce has been
rapid, and has spearheaded the development of industrial might that has
carried Ohio to contention for the lead among industrial states in the
nation. Indirect effects and repercussions of this growth are evidenced,
among other ways, in land use. The declining area and importance of farm
land in this and similar areas is a matter of common knowledge to most
observers.
Table 15

Population, Increase in Population, and Area of Five Urban Counties, in Northeastern Ohio, 1959

<table>
<thead>
<tr>
<th>Area</th>
<th>Population Estimated 7-1-59</th>
<th>Increase 4-1-50 to 7-1-59</th>
<th>Land Area (acres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cuyahoga County</td>
<td>1,665,998</td>
<td>276,456</td>
<td>291,840</td>
</tr>
<tr>
<td>Lake County</td>
<td>130,223</td>
<td>54,244</td>
<td>148,480</td>
</tr>
<tr>
<td>Mahoning County</td>
<td>298,676</td>
<td>41,047</td>
<td>268,160</td>
</tr>
<tr>
<td>Stark County</td>
<td>336,919</td>
<td>53,725</td>
<td>366,720</td>
</tr>
<tr>
<td>Summit County</td>
<td>500,312</td>
<td>90,280</td>
<td>264,320</td>
</tr>
<tr>
<td>5-County Area</td>
<td>2,932,118</td>
<td>515,752</td>
<td>1,339,520</td>
</tr>
<tr>
<td>Ohio</td>
<td>9,644,783</td>
<td>1,698,156</td>
<td>26,240,000</td>
</tr>
</tbody>
</table>


Census of Agriculture, 1954.

The analysis subsequently developed in this section indicates that four factors appear to be important in this pattern of change: speculation in land, automobile transportation, low agricultural opportunity cost of land, and changes in industrial and other needs for land.

The area of land used for all agricultural purposes in these five counties declined precipitously between the 1920 and 1930 censuses. Induced by the inflation and the prosperity of the 1920's, a land boom developed. Intertilled cropland decreased 35 percent; small grains, 47 percent; hay, 44 percent; woodland in farms, 44 percent; and land in farms, 33 percent in one decade. Much rural land was developed for urban use by 1930, in anticipation of speculative profits from resale which would be easy with continued prosperity and further urbanization.
When the land boom collapsed in the 1930's, much of the land did not and could not economically return to its former use because of the sunk costs of street improvements and sewer installations, the fragmented holding of titles, the cost of foreclosure, and other problems. Only the best agricultural land—that which was usable for intertilled crops—reverted to its pre-urbanization use in significant proportions.

There is a concern among experienced observers that we stand on the threshold of a similar blunder at the present time. The growth of cities, their tendency to link themselves together by ribbon developments along highways, and the increasing emphasis placed on urbanization as the ultimate and most desirable use of land will naturally and more or less inevitably result in a "megalopolis." Such a polynucleated chain of cities or conurbation appears to be taking shape across the southern shore of Lake Erie and may eventually link Cleveland with Pittsburgh, Detroit with Toledo, or even—as seen by the more visionary—connect Detroit and Pittsburgh in one gigantic concentration of humanity and capital, for which no adequately descriptive term has been coined save "megalopolis."

Projections of the Impact of Urbanization

The increasing importance of urbanization and industrialization in this five-county area of northeastern Ohio can be seen from the data in Table 16 and Figure 14. A capsule summary of the trends and prospects

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This problem was typical of urban-influenced areas. An excellent discussion of these general relationships with specific examples is available in Philip H. Cornick, Premature Subdivision and Its Consequences (New York: Columbia University Institute of Public Administration, 1938).
for land use in this area, based upon these data, is that agricultural uses of land are declining at such a rate that farming may be eliminated altogether within a few decades.

In this five-county area, all of the agricultural uses of land have declined in acreage since 1900. Trend lines fitted to these series do not have the same slope, but the slopes relative to their bases are surprisingly similar. The projection of trend lines in Figure 14 shows convergence of these lines at or near zero in 2000, indicating that with continuation of past trends in land use, agriculture will have been virtually eliminated by 2000, except possibly for some intensive types such as truck gardening.

The inventory and predictions of the Conservation Needs Committee indicate that the foregoing projection is in accord with the expectations of local leaders whose ears are to the ground. These predictions are presented in Table 17. The CN "inventory acreage" is derived by deducting urban and built-up areas, water areas and non-crop federal land from the total land area. Thus, it is not comparable to land in farms, but it would be similarly affected by increase in area of urban land. Other uses of land as shown in this table are likewise not strictly comparable to census data because of definitions used, but the similarity of these trends to those derived by projection techniques is clearly evident.

\[ Y \text{ (acreage of intertilled crops)} = 134,089 - 964 X; Y \text{ (acreage of small grains)} = 225,055 - 2,587 X; Y \text{ (acreage of meadow cut as hay)} = 199,680 - 2,335 X; Y \text{ (acreage of woodland in farms)} = 160,833 - 1,649 X; Y \text{ (acreage of land in farms)} = 1,211,195 - 11,816 X. \] In each case, origin at 1900, \(X = 1\) year.
Table 16

Land Utilization in a Five-County Area of Northeastern Ohio, by Census Periods 1900-1955, and Projection of Trends to 1975 and 2000

(Thousands of acres)

<table>
<thead>
<tr>
<th>Land Use</th>
<th>1900</th>
<th>1910</th>
<th>1920</th>
<th>1930</th>
<th>1940</th>
<th>1950</th>
<th>1955</th>
<th>Projectionsa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cropland:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intertilled crops</td>
<td>130</td>
<td>134</td>
<td>121</td>
<td>79</td>
<td>111</td>
<td>86</td>
<td>80</td>
<td>62</td>
</tr>
<tr>
<td>Small grains</td>
<td>233</td>
<td>200</td>
<td>196</td>
<td>103</td>
<td>105</td>
<td>114</td>
<td>94</td>
<td>31</td>
</tr>
<tr>
<td>Meadow cut as hay</td>
<td>187</td>
<td>184</td>
<td>187</td>
<td>104</td>
<td>94</td>
<td>80</td>
<td>83</td>
<td>25</td>
</tr>
<tr>
<td>Total of crops specifiedb,c</td>
<td>549</td>
<td>518</td>
<td>504</td>
<td>285</td>
<td>310</td>
<td>280</td>
<td>257</td>
<td>117</td>
</tr>
<tr>
<td>Woodland in farms</td>
<td>NRd</td>
<td>145</td>
<td>152</td>
<td>85</td>
<td>74</td>
<td>93</td>
<td>77</td>
<td>37</td>
</tr>
<tr>
<td>Other land in farms</td>
<td>649</td>
<td>483</td>
<td>375</td>
<td>317</td>
<td>379</td>
<td>277</td>
<td>244</td>
<td>170</td>
</tr>
<tr>
<td>Total land in farmsc</td>
<td>1199</td>
<td>1146</td>
<td>1032</td>
<td>687</td>
<td>764</td>
<td>650</td>
<td>578</td>
<td>325</td>
</tr>
<tr>
<td>Land not in farms</td>
<td>141</td>
<td>193</td>
<td>308</td>
<td>652</td>
<td>576</td>
<td>690</td>
<td>761</td>
<td>1015</td>
</tr>
<tr>
<td>Total land areac,e</td>
<td>1340</td>
<td>1340</td>
<td>1340</td>
<td>1340</td>
<td>1340</td>
<td>1340</td>
<td>1340</td>
<td>1340</td>
</tr>
</tbody>
</table>

Projections are based on straight line trends fitted by least squares and on sums of projected components. Projections of negative acreage are changed to zero.

Not to be construed as a total of all crops raised or total harvested cropland.

Components may not add to totals because of rounding.

NR = Not reported in census data separately from other land in farms.

For uniformity, the area as given in the 1920 census is used throughout.

Source: Census of Agriculture: 1900 through 1954.
Figure 14. Land Utilization in a Five-County Area of Northeastern Ohio, 1900-1955, and Projection of Trends to 1975 and 2000

Source: Table 16
Table 17

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Inventory 1958</th>
<th>Projection 1975</th>
<th>Change Amount</th>
<th>Change Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cropland and rotated pasture</td>
<td>355</td>
<td>235</td>
<td>-120</td>
<td>-39%</td>
</tr>
<tr>
<td>Woodland</td>
<td>160</td>
<td>100</td>
<td>-60</td>
<td>-38%</td>
</tr>
<tr>
<td>Pasture land</td>
<td>69</td>
<td>52</td>
<td>-17</td>
<td>-25%</td>
</tr>
<tr>
<td>Other land</td>
<td>171</td>
<td>122</td>
<td>-49</td>
<td>-29%</td>
</tr>
<tr>
<td>Inventory acreage</td>
<td>755</td>
<td>509</td>
<td>-246</td>
<td>-33%</td>
</tr>
<tr>
<td>Excluded area</td>
<td>584</td>
<td>830</td>
<td>+246</td>
<td>+42%</td>
</tr>
</tbody>
</table>

Source: Preliminary data of the Ohio Committee for the National Inventory of Soil and Water Conservation Needs.

Projection of the trends indicated by the CN figures for 1958 and 1975 indicates that both inventory acreage and cropland will vanish from the scene in 2010 and 2008, respectively.

It is unlikely that these trends will continue at the same slope as the zero level is approached. Institutional factors in land use resist urbanization, and a certain amount of agricultural use of land persists for years or generations after a farming community is superficially urbanized. However, even in 1955, only 43 percent of the area of these five counties was in farms, and the 1960 census, when available, will probably show it to be less than 40 percent. In view of the already small and declining importance of agriculture as contrasted with the great and increasing importance of the non-agricultural sector, it is evident that the land use picture in these five counties
is dominated by urbanization. For this reason, the balance of this section will concentrate on urban aspects of land use.

Factors Affecting Land Use in Urban Areas

Non-farm land is a residual category in the census data, being the remainder when land in farms is subtracted from total area. Some of the components of non-farm land are quite properly viewed as residuals. Non-farm forest in particular is a residual claimant, as was discussed with respect to retirement of submarginal farm land in southeastern Ohio. However, land for streets and other transportation use, land for residential, industrial and commercial purposes and other intensive uses is in no sense residual. These uses represent the deliberate application of large quantities of both capital and labor to relatively small areas of land and thus are more properly handled as increments than as residuals. A brief attempt is made here to analyze non-farm land use as if all of it were incremental or augmentative, as a function of some other factor or factors.

A possible causative factor in the amount of non-farm land is, of course, the size of the non-farm population. In studying the relationships of these variables, the population considered ideally should be the non-farm or urban-oriented population. This would include all of the population other than farmers, i.e., urban plus rural non-farm population. Since the separation of rural population into farm and non-farm divisions was not done for the censuses of 1900 and 1910, a comparable series utilizing this concept for 1900-1955 is impossible. Inclusion of the rural farm segment (using total population figures)
introduces a smaller and less variable error than does exclusion of the rural non-farm segment (using urban population only).

The relationship between total population and non-farm land in this five-county area is shown in Table 18. The average density of urban population reached a peak in 1920 and (disregarding 1930 because of the excessive and premature subdivision to which reference has already been made) has declined since that time. Increasing average density of population through 1920 is in line with a historical view of the impact of transportation methods on the growth of cities. The accepted means of transportation to and from one's place of employment was the street car or by walking. With these limitations, cities were restricted as to the area they could encompass. The largest cities were the most densely populated ones, and vertical expansion was necessary to crowd more people into the limited area which was accessible to employment with the available means of transportation.

Table 18

Non-Farm Land, Number and Density of Population in a Five-County Area in Northeastern Ohio, 1900-1955

(000 omitted from population and acreage)

<table>
<thead>
<tr>
<th></th>
<th>1900</th>
<th>1910</th>
<th>1920</th>
<th>1930</th>
<th>1940</th>
<th>1950</th>
<th>1955</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-farm land, acres</td>
<td>141</td>
<td>193</td>
<td>308</td>
<td>652</td>
<td>576</td>
<td>690</td>
<td>761</td>
</tr>
<tr>
<td>Total population</td>
<td>697</td>
<td>1008</td>
<td>1622</td>
<td>2045</td>
<td>2077</td>
<td>2417</td>
<td>2600</td>
</tr>
<tr>
<td>Average density (persons per non-farm acre)</td>
<td>4.96</td>
<td>5.21</td>
<td>5.27</td>
<td>3.14</td>
<td>3.61</td>
<td>3.50</td>
<td>3.42</td>
</tr>
<tr>
<td>Non-farm land per 1,000 population, acres</td>
<td>202</td>
<td>192</td>
<td>190</td>
<td>319</td>
<td>277</td>
<td>285</td>
<td>293</td>
</tr>
</tbody>
</table>

Source: Census of Agriculture: 1900 through 1954.

Census of Population: 1900 through 1954.
In the decade of the 1920's, America's adoption of the automobile began to affect land use and the characteristics of cities. To a greater and ever greater extent, this mode of transportation has freed the city from its areal bonds and its spatial limitations. Cities have become free to expand, or at least free to choose between horizontal and vertical expansion on the basis of comparative costs and returns. The lower land prices at the periphery of the city have exercised great influence on geographical patterns of investment, and the term "centrifugal force" has been applied to the tendency of business and capital to move outward from the center of town. Where land was rationed by reliance on pedestrian or horse transportation, other factors of production were substituted for land. The result was taller office buildings, smaller residential lots, and multi-story factories and schools. When the automobile broke the spatial bonds, land began to substitute increasingly for other factors of production in the makeup of a city. This substitution is still going on, and it appears at times that the optimum substitution ratio has not yet been achieved, that the mix is continually being diluted with more land.

The choice between vertical and horizontal expansion of cities has been indicated as a problem subject to budgeting of alternative costs and returns. In such an analysis, the opportunity cost of the land at the periphery of the city would necessarily be a factor. Comparison of the incremental densities of urban communities with high or with low opportunity cost of the land should, in theory, show more liberal use of land (lower incremental density) when land has lower opportunity cost. Therefore, it might be hypothesized that urban communities in the
northeastern part of the state, where land is of a productivity level below the state average, would respond to "centrifugal force" to a greater extent than in northwestern Ohio where land is of high agricultural productivity.

To test the hypothesis that land with high agricultural potential is used more intensively for urban development, three counties were selected from the area where soils generally are of below average productivity. These counties were paired on the basis of 1950 total population with three counties selected from areas where soil productivity is generally above average. Density of population for these two groups of counties is shown in Table 19. There is much variation from county to county, even within the soil groups. Generally, in the counties with larger population both average and marginal density of population is greater. This is as would be expected. All of the density measures computed indicate more people per unit of land on the better soils. Based on aggregative figures for the three-county groups, urban population in the better soil areas was approximately twice as dense in both 1900 and 1950 as in the poorer soil areas. Marginal density for 1900-1920 was extremely variable, largely because Lake and Lorain counties were sparsely populated at this time while Summit County (Akron) experienced an extremely rapid growth between 1910 and 1920. Similarity of the averages for the two soil groups indicates (perhaps) equal reliance on pedestrian transportation. In the period 1920-1950, when the impact of automobile transportation made itself felt, marginal density was less in both areas. However, in all of the counties with above average soil productivity, the 1920-1950 marginal
density was greater than in any of the three counties in the poorer soil group, and the average was three times as great. The obvious conclusion is that in this sample, in counties of comparable population, land with low opportunity cost in terms of agricultural productivity was used with three times the liberality (measured in population density) as land with high opportunity cost.

In view of the variation and overlapping of the computed densities for the two groups of counties, it is certain that other factors besides productivity of soil also influence density. Some of the other characteristics of urban uses should be examined for indications of the magnitude and incidence of their effects. With respect to the differences in density by soil area, for example, it is possible that these differences can be attributed to regional differences in industry. Industrial needs for land are quite variable; these variations could conceivably account for a large part of the differences in population density observed.

Variation in a myriad of urban characteristics and factors results in large aggregate variation in land use patterns. Some of these characteristics are engineering factors; some are psychological or cultural factors, but most have become institutions and as such are resistant to change. A brief discussion of some of these factors follows.
### Table 19
Density of Population in Six Counties Grouped by Productivity of Soil, 1900-1950

<table>
<thead>
<tr>
<th></th>
<th>Above average soil productivity</th>
<th>Below average soil productivity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Allen County</td>
<td>Butler County</td>
</tr>
<tr>
<td><strong>Total Population, 1950</strong></td>
<td>88,183</td>
<td>147,203</td>
</tr>
<tr>
<td><strong>Average Density,</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1900</td>
<td>2.80</td>
<td>2.69</td>
</tr>
<tr>
<td>1950</td>
<td>2.56</td>
<td>3.11</td>
</tr>
<tr>
<td><strong>Marginal Density,</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1900-1920</td>
<td>5.34</td>
<td>3.73</td>
</tr>
<tr>
<td>1920-1950</td>
<td>1.47</td>
<td>3.32</td>
</tr>
</tbody>
</table>

*Average density: total population per acre of non-farm land.*

*Marginal density: increase in population per acre of increase in non-farm land.*

**Source:** *Census of Agriculture and Census of Population, 1900 through 1954.*
Reference has already been made to the automobile. Its utility in transportation is dependent on (1) an adequate system of roads and parking places, (2) dependability of the automobile as a machine, and (3) its acceptance by society. The last condition is not automatic, but certainly the automobile has been accepted, almost as a master rather than a servant or tool. The automobile has become an institution and a status symbol, and this has further increased the demand for land. Two-car families are more mobile, can live further out in the country, need more space for the two-car garage, and because they add to the highway congestion increase the demand for highways. A word about the new status symbol, the boat, may be in order. Owners of boats need, want and will pay for water areas on which to sail, water ski, float or travel. The area of water accessible to boat owners will soon be saturated and the result will be more traffic on the highways in search of boating room, plus agitation for more reservoirs and lakes on which to frolic. Use of land as boating grounds, like other outdoor recreational uses, is a very extensive use of land and requires large areas. Furthermore, increasing the water area generally means flooding good land, of high value for agricultural purposes. Thus, pleasure boats and their use are characteristics of a society affluent in both land and consumers' goods.

The air-castle built most frequently by a previous generation was a vine-covered cottage by the wayside. The current generation prefers either a ranch-type or a split level house, but in either case, a broad expanse of lawn is a part of the vision. This vision is becoming reality for great numbers of people. For those whose dreamhouse is
located outside of town and away from municipal water lines and sewers, rural zoning and health requirements dictate large lots because of the wells and septic tanks used under these circumstances. Larger population, a higher proportion of home owners, and larger lots expand in geometrical progression so that the residential real estate needs represent a very important component of aggregate land use.

The commercial aspects of a community require space, too. A generation ago, a row of shops along Main Street in a county seat town did not require much area; but the trend nowadays is toward shopping centers with acres of parking space, toward drive-in restaurants, drive-in banks, and drive-in theatres. Even the shop keeper on Main Street has space problems: if he can't provide parking for his customers, they will patronize the establishment which does provide parking.

While the multistory office building does not appear to be obsolete, certainly the heyday of the skyscraper is past, for the nonce. Office buildings are now frequently built as low, rambling structures on the outskirts of town. This trend is even more evident for factories, warehouses, and schools. Availability of the automobile (and truck) makes the more distant site acceptable; use of the automobile makes the distant site preferable; acceptance of the distant site makes the automobile mandatory; being forced to have and use an automobile part of the time, the problem of what to do with it the rest of the time makes downtown unacceptable. Thus, the chain reaction goes on and on, and urban communities expand themselves almost endlessly.
Examination of three geographical areas of Ohio has shown that there exists a diversity of trends in land use and that there are equally diverse reasons for these trends. Some of the significant items shown by this examination are mentioned here.

Relative to the total area of agricultural land, loss to urban and industrial uses has been small in areas where agriculture is well adapted from the standpoint of soils resources. In such areas the importance of agriculture has not been seriously reduced, viewed in the aggregate, although in small areas farming has been eliminated.

In areas of intensive urban and industrial development, all other uses are being crowded out.

In some parts of the state, a large proportion of the land shifted out of agricultural use is going into less intensive uses such as forestry and/or idleness.

The aggregative picture of land use for Ohio fails to indicate the importance and extent of some of the component changes in land use. Significant changes in one area may be neutralized by changes in the opposite direction occurring in other areas. Instances of this neutralization and concealment of trends and developments by aggregation are the increase in intensity of use of cropland in northwestern Ohio and the corresponding growth in acreage of intertilled crops; the relocation of forest areas in Ohio with diminution of acreage in northwestern Ohio and increase in southeastern Ohio; and the extent of supersession of agricultural land by the urban complex of uses, in certain urban influenced counties.
The consequences of current land use and the repercussions of the land use pattern which is emerging cannot be grasped as a simple concept. The problem is not simple. Land for industry is needed if we are to have industry. Land for residential development is needed if we are to have homes for our citizens. Land for agriculture is needed if we are to have food. The question is this: How much land is needed for industry, for houses, for food production? How much land is needed for recreation, transportation, mineral use, forestry and all other uses? Certainly the trends in land use are important to give perspective. But trends and history give at best a poor answer to the question of needs, or of desirable rather than customary allocation of land. A plan or design for the allocation of land as it should be used, under an optimum allocation of the resource, is needed to maximize the objectives and goals of society.

Formulation of such a plan is undertaken in the next chapter.
In the evaluation of a land use pattern based on a projection of trends in land use, a standard or criterion is needed against which this pattern can be measured or to which it can be compared. The formulation of such a criterion requires the use of available data quantifying the land requirements; for those uses of land where such data are not available, standards for land needs must be constructed. This is necessary not merely to determine what would be the total amount of land needed but to serve as a guide to what might be considered a desirable or, hopefully, an optimum allocation of resources for the present or for a period in the future.

Judgment and the "Ideal" Model

Formulation of a standard or criterion is equivalent to the building of a pattern or a model for land use. The design of the model depends upon the subjective valuation of many component factors with regard to what is desirable; thus it could properly be called a judgment model. However, the formulation of a model, as subsequently done in this study, involves much search for authoritative data and much study and comparison of alternative bases for decision. The term "judgment" may imply a hasty, arbitrary or unfounded choice; this impression, while incompatible with the methods used, may best be avoided by choice of a different label.
The alternative of terming this product of research and thought an "ideal" land use plan, may, on the other hand, give the impression of unbounded conceit or of a degree of mathematical or logical precision which is impossible in view of human frailties and the shortcomings of the available data. This latter risk must be accepted.

Many of the primary determinants of the ideal plan—the structural members of the model, as it were—are obscured by uncertainty. The pattern formulated is bound to be likewise shrouded with uncertainty. Perhaps a plan with bands or ranges of estimation would be more realistic than the simple point estimates utilized herein, but in the current state of (lack of) refinement, confidence limits are unattainable.

The precise technique of formulating an ideal plan must vary, depending upon the tools and materials available. The plan formulated in this study starts with a projection of the population of the state of Ohio. Many uses of land appear to be proportional to population; if the proportion or coefficient can be discovered, the amount of land needed can be computed for any population. The proportions used are, in some cases, based on present rates of use; in other cases, they are based on the extrapolation of a trend in the proportions; in still other cases, some rather subjective indications are used to derive coefficients which appear to be more applicable than those derived by other means. In general, present rates or trends in per capita use were interpreted as reflecting or indicating the desires of the people and, therefore, pointing toward the use of land which would maximize human satisfactions. Further discussion of the derivation of
coefficients accompanies their presentation in subsequent sections. Not all uses of land considered appear to be proportionate to population. For these exceptions, other means of deriving the land use under optimum conditions are necessary. These derivations also are discussed as they are introduced.

Land requirements for 1975 and for 2000 are developed for the following categories of land use:

Urban: Residential and Neighborhood
        Industrial
        Business and Commercial
        Public and Semi-Public Property

Transportation
Recreational
Mineral and Extractive
Agricultural
Forest

Ohio's Population in 1975 and 2000

A projection of the population of Ohio to certain points in the future is necessary as the basis for developing a judgment model for allocation of land use applicable to those points in the future. Whether the projections of population which are used in this study are "realistic" in any sense, or whether they approximate the actual population of Ohio achieved by those dates, is not of major importance from the standpoint of developing methodology for the evaluation of land resource allocation. It should be stressed that neither the method nor the assumptions involved in the projection of population is on trial.
However, it is desirable to use the best, the most realistic, projections of population which are available in order to permit the test of reasonableness in subsequent steps, and to permit the acid test in the cauldron of history.

The projections used in this study resemble and are based on those made by the Bureau of the Census. The deviations from Census Bureau methods in further extending the projections were made in the interest of simplicity and saving of time. A brief discussion of the development of these population projections follows.

The most recent projection by the Census Bureau of population by states was made in 1957. Data from that projection for Ohio and the United States are presented in Table 20. The assumptions upon which the four series of projections are based are given in Appendix B. The Series II projection for 1960 comes closer to current population estimates for Ohio than do the other projections, and on the basis of this demonstrated accuracy, Series II is selected as the foundation of further projection in this study. The assumptions basic to Series II are:

a. Migration -- 1940-55 levels of migration remain constant throughout the projection period.


c. Mortality -- The decreases in mortality observed during the 1940's will continue until 1960, after which mortality rates will remain constant at 1955-60 levels.

---

Table 20

<table>
<thead>
<tr>
<th>Series</th>
<th>Projected Population (thousands)</th>
<th>Proportion of U.S. Population in Ohio (percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>11,035</td>
<td>11,109</td>
</tr>
<tr>
<td>II</td>
<td>9,807</td>
<td>10,684</td>
</tr>
<tr>
<td>III</td>
<td>9,715</td>
<td>10,494</td>
</tr>
<tr>
<td>IV</td>
<td>9,638</td>
<td>10,273</td>
</tr>
</tbody>
</table>


Table 20 indicates that Ohio will have between 5.5 and 5.7 percent of the population of the United States (exclusive of Alaska and Hawaii) in the years 1960-1970, with Ohio's share increasing somewhat over time. By applying the appropriate percentage to a more recent projection of the United States population, an updated estimate of Ohio's population is derived for the years 1960-1980, quinquennially. This more recent projection is based on assumptions somewhat different from those underlying Table 20, but these are in the nature of refinements rather than basic changes.

Derivation of the Ohio population on a proportionate basis from national projections is presented in Table 21. The Series II figure for 1975 is 13.48 million. This figure, rounded to 13.5 million, will
be used throughout the balance of this study as the 1975 population of Ohio for purposes of planning the allocation of land use.

Table 21
Projected Population of the United States and Derived Population of Ohio under Four Series, Quinquennially, 1960-1980

<table>
<thead>
<tr>
<th>Year</th>
<th>United States&quot;</th>
<th>Ohio&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Series</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I</td>
<td>II</td>
</tr>
<tr>
<td>1960</td>
<td>181,134</td>
<td>180,126</td>
</tr>
<tr>
<td>1965</td>
<td>198,950</td>
<td>195,747</td>
</tr>
<tr>
<td>1970</td>
<td>219,474</td>
<td>213,810</td>
</tr>
<tr>
<td>1975</td>
<td>243,880</td>
<td>235,246</td>
</tr>
<tr>
<td>1980</td>
<td>272,557</td>
<td>259,981</td>
</tr>
</tbody>
</table>

a The assumptions basic to this projection are somewhat different from those for Table 20. These assumptions are also given in Appendix B.

b Ohio population derived from U. S. population by percentages from Table 20.

c Percentages for 1970 were used to derive Ohio population for 1975 and 1980.


Table 1 and calculations.

The 1980 figures represent the halfway mark between the present and 2000; the Bureau of the Census has published no projections beyond this point. A crude extrapolation can be made by assuming that the average rate of growth for the 20-year period, 1980-2000, will duplicate that
for 1960-1980. Accordingly, in Table 22, the 1980 figures have been increased by the same percentage which the 1980 figure represents over 1960 to yield a figure for 2000.

These projections for 2000 range from about 17 million to over 25 million. It seems reasonable to choose, as the basis for succeeding steps, the projection comparable to the 1975 selection. This one is Series II: 22.238 million. For convenience and in recognition of the inaccuracies involved in its computation, this Series II projection will be rounded to 22 million.
Table 22
Projections of United States and Ohio Population, 1960-1980, for Four Series, and Extrapolation by Percentage to 2000
(population in thousands)

<table>
<thead>
<tr>
<th></th>
<th>United States</th>
<th>Ohio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Series I</td>
<td>Series II</td>
</tr>
<tr>
<td>1 1960</td>
<td>181,154</td>
<td>180,126</td>
</tr>
<tr>
<td>2 1980</td>
<td>272,557</td>
<td>259,981</td>
</tr>
<tr>
<td>3 20-yr. increase</td>
<td>91,403</td>
<td>79,855</td>
</tr>
<tr>
<td>4 Percentage increase over 1960</td>
<td>50.46%</td>
<td>44.33%</td>
</tr>
<tr>
<td>5 Indicated percent of 1980 population</td>
<td>137,532</td>
<td>115,250</td>
</tr>
<tr>
<td>6 2000</td>
<td>410,089</td>
<td>375,231</td>
</tr>
</tbody>
</table>

\[a\] Line 2 minus line 1.

\[b\] Line 3 divided by line 1; expressed as a percent.

\[c\] Line 4 times line 2.

\[d\] Line 5 plus line 2.

Source: Table 21 and calculations.
In the balance of this study, the calculation of land requirements is based upon the 1975 and 2000 population projections just derived. These population figures are treated as given, and no alternative population figures are used. Prediction of population is by no means as certain a process as this would imply. The factors influencing population are net natural increase (or decrease) and migration. Natural increase is the excess of fertility or birth rate over mortality rate. All three of these factors are now accepted as being subject to man's control, although mortality in a civilized country is not likely to change rapidly. Short of such grim possibilities as decimation or extinction of the race by thermonuclear reaction and its consequences, birth rate and migration are the aggregation of individual decisions regarding reproduction and geographic relocation. These decisions are influenced by economic conditions or expectations of economic conditions. Real or expected competition between additions to the family and material wants, such as a new automobile or better housing, have a profound effect on the fertility of individual families and, thus, on the rate of population increase. Because of the intangibility and unpredictability of the effect of economic levels as well as the difficulty of prediction of what those levels will be, it is entirely possible that the population of Ohio will fall considerably short of, or greatly exceed, the figure of 22 million for 2000. Similarly, the projected U. S. population for 2000 of 375 million (Series II) may be too high or too low.
Requirements in 1975 and 2000 for Specific Uses of Land

In the following section, the quantitative need for land in each of several categories of uses is developed. For each use, the per capita coefficient or other basis of estimation is transformed into an acreage figure indicating area needs for 1975 and 2000.

Residential and Neighborhood Space Requirements

Both the desire and the effective demand for space in connection with dwelling units vary greatly. Presumably by preference, some live in expansive country estates, while some, either by choice or of necessity, live in crowded apartments. It may be assumed that the new dwelling units of which construction is started accurately reflect the effective demand of the average American for various types of housing. A quantification of these desires can be obtained from census figures on new dwelling units started, during a period of several years which were relatively free of influences such as wars and depressions. Accordingly, new permanent non-farm dwelling units started in the nine-year period, 1950-1958, were totaled, and a percentage distribution computed by type of dwelling unit (Table 23). Approximately 85 percent of the dwelling units started during this period were single-family residences, 3 percent were 2-family, and 12 percent were multi-family.

An "ideal" plan should allocate land according to the desires of the people. Desires are different from effective demand. No doubt more people have the desire for brick, ranch-type houses on one-acre lots than have both the desire and the purchasing power which make up
effective demand for units of this commodity. Under actual 1950-1958 conditions, the people who had effective demand for new dwelling units voted with their dollars for the types of dwellings indicated in Table 23. Their desires, with respect to dwelling units, are unknown. Rather than make arbitrary changes in their preferences as revealed by their purchases, the assumption is made that, under the conditions of population density projected for 1975 and 2000, competition for land would result in allocation of the scarce land to types of housing in the same proportions that allocation of scarce dollars indicated in the years sampled.

Table 23

New Permanent Non-Farm Dwelling Units Started, by Type, United States, 1950-1958

(Thousands of units)

<table>
<thead>
<tr>
<th>Year</th>
<th>1 Family</th>
<th>2 Family</th>
<th>Multi-Family</th>
<th>Total²</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950</td>
<td>1,154</td>
<td>45</td>
<td>197</td>
<td>1,396</td>
</tr>
<tr>
<td>1951</td>
<td>900</td>
<td>40</td>
<td>151</td>
<td>1,091</td>
</tr>
<tr>
<td>1952</td>
<td>943</td>
<td>46</td>
<td>139</td>
<td>1,127</td>
</tr>
<tr>
<td>1953</td>
<td>938</td>
<td>42</td>
<td>125</td>
<td>1,104</td>
</tr>
<tr>
<td>1954</td>
<td>1,078</td>
<td>34</td>
<td>108</td>
<td>1,220</td>
</tr>
<tr>
<td>1955</td>
<td>1,194</td>
<td>33</td>
<td>102</td>
<td>1,329</td>
</tr>
<tr>
<td>1956</td>
<td>990</td>
<td>31</td>
<td>97</td>
<td>1,118</td>
</tr>
<tr>
<td>1957</td>
<td>873</td>
<td>33</td>
<td>136</td>
<td>1,042</td>
</tr>
<tr>
<td>1958</td>
<td>975</td>
<td>39</td>
<td>195</td>
<td>1,209</td>
</tr>
<tr>
<td>Total</td>
<td>9,045</td>
<td>343</td>
<td>1,250</td>
<td>10,636</td>
</tr>
</tbody>
</table>

Percent 85.04% 3.22% 11.75% 100.00%

²Components may not add to totals because of rounding.

Ibid., 1952, p. 761.
In the absence of anything other than conjecture about the size of lot which will in the future be preferred or indeed which is in the present preferred, judgment standards for size of lot are to be preferred over historical data. The committee on the Hygiene of Housing of the American Public Health Association has established recommended area allowances per family for the various dwelling types, basing their recommendations upon needs for the following: play space for small children; outdoor hobbies; clothes drying; storage of refuse pending removal; storage for lawn and garden tools, bicycles, etc.; approaches for cars and pedestrians; and storage and parking for cars. The recommendations of this committee are presented in Table 24. Also included in Table 24 are the land requirements per family resulting from recommended allowance for community facilities: schools, outdoor recreation, social and cultural facilities, neighborhood shopping, etc.

The recommendations of Table 24 are intended as minima rather than optima, and perhaps for use in an "ideal" model some modification would be justified for that reason. However, a more important adjustment is called for by the high proportion of new homes, and particularly of new one-family homes, which is built outside of cities and so is hardly subject to the same urban restrictions. The number of private non-farm dwellings built outside of cities exceeded the number in cities by 1953.²

²Barlowe, p. 90.
## Table 24

Recommended Lot Size and Land Area Allowances Per Family with Various Dwelling Types

<table>
<thead>
<tr>
<th>Dwelling Type</th>
<th>Lot Size or Equivalent (feet)</th>
<th>Net Residential Area per Family</th>
<th>Land Areas Per Family for Total Neighborhood Needs</th>
</tr>
</thead>
<tbody>
<tr>
<td>One Family Detached</td>
<td>60 x 100</td>
<td>6,000</td>
<td>8,440</td>
</tr>
<tr>
<td>One Family Semi-Detached</td>
<td>80 x 100, plus 40 ft.</td>
<td>4,000</td>
<td>5,840</td>
</tr>
<tr>
<td>Two Family Detached</td>
<td>20 x 100, plus 40 ft.</td>
<td>2,400</td>
<td>3,740</td>
</tr>
<tr>
<td>One Family Attached (row)</td>
<td>48 x 100</td>
<td>1,465</td>
<td>2,795</td>
</tr>
<tr>
<td>Two Family Semi-Detached</td>
<td>48 x 100</td>
<td>1,465</td>
<td>2,795</td>
</tr>
<tr>
<td>Multi-Family Dwellings:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Story</td>
<td>1,465</td>
<td>53</td>
<td>2,795</td>
</tr>
<tr>
<td>3 Story</td>
<td>985</td>
<td>45</td>
<td>2,195</td>
</tr>
<tr>
<td>6 Story</td>
<td>570</td>
<td>36</td>
<td>1,580</td>
</tr>
<tr>
<td>9 Story</td>
<td>515</td>
<td>35</td>
<td>1,465</td>
</tr>
<tr>
<td>13 Story</td>
<td>450</td>
<td>32</td>
<td>1,400</td>
</tr>
</tbody>
</table>

In 1950-56, about 38 percent of dwelling units were built outside of the 180 standard metropolitan areas; however, many dwellings outside of SMA's are inside smaller cities, while the SMA's include some land which, by most standards, would be classified as rural.

It is apparent that a substantial proportion—let us assume one-third—of new residences will be constructed outside of urban areas.

The space which will be utilized by these dwellings will greatly exceed the 6000 square feet figure applicable to urban areas according to Table 24. A study of zoning ordinances applicable to rural areas of Ohio reveals that the typical ordinance requires in excess of 20,000 square feet per residential lot (see Table 25). While the houses built outside of cities may not be distributed among the different lot sizes in the same fashion as the zoning ordinances are distributed, the smaller sizes of lots frequently encounter trouble and dissatisfaction with self-contained water supply systems where septic tanks must be used for sewage disposal. Therefore, it is reasonable to assume an average lot size for housing in rural areas of 20,000 square feet.

In the case of urban dwellings, from about 1,000 up to as much as 2,440 square feet of land area per family was required by other neighborhood needs (see Table 24). For rural dwellings, needs of this type are less clear-cut. The burden of school sites and cultural facilities tends to be transferred to nearby urban areas; outdoor recreation space is self-contained in rural lots, and additional neighborhood shopping

---

3April, 1950 through 1956: 4,157,000 built outside SMA's out of 10,920,000 total or 38.1 percent. Figures from Statistical Abstract of the United States, 1959.
facilities are not demanded. For these reasons adjustment of the
20,000 square feet per lot to accommodate "neighborhood needs" is
thought to be unnecessary.

Table 25
Minimum Permitted Size of Residential Lot in Rural Areas,
80 Zoning Ordinances, Ohio, 1959

<table>
<thead>
<tr>
<th>Minimum Size</th>
<th>Number of Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5 Acres (65,340 sq. ft.)</td>
<td>1</td>
</tr>
<tr>
<td>Approximately 1 Acre</td>
<td></td>
</tr>
<tr>
<td>(Range of 40-45,000 sq. ft.)</td>
<td>14</td>
</tr>
<tr>
<td>30-32,000 sq. ft.</td>
<td>8</td>
</tr>
<tr>
<td>20-22,000 sq. ft.</td>
<td>31</td>
</tr>
<tr>
<td>15-16,000 sq. ft.</td>
<td>9</td>
</tr>
<tr>
<td>10-12,750 sq. ft.</td>
<td>7</td>
</tr>
<tr>
<td>5-8,250 sq. ft.</td>
<td>4</td>
</tr>
<tr>
<td>No minimum named</td>
<td>6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>80</strong></td>
</tr>
</tbody>
</table>

*aMean of 80 cases: 22,560 sq. ft.
Median: 20,900 sq. ft.

Source: H. R. Moore and William A. Wayt, Policies and Standards
in Rural Zoning (Wooster: The Ohio Agricultural Experiment Station,
to be published in 1960), p. 28 of typed manuscript.

Assembling the foregoing figures permits calculation of a weighted
average of land area requirements for residential and neighborhood
purposes, under a distribution of housing types which will obtain when
all the population lives in the kind of dwellings that current patterns
indicate are favored. This weighted average, developed from Table 26,
indicates an "ideal" allocation of land for residential and neighborhood
purposes of 11,023 square feet per family. Using 3.6 persons as the average size of family (as was done by the references cited), the per capita land requirements for residential and neighborhood purposes are 3,062 square feet or 0.070 acres per capita.

Table 26
Distribution of Dwellings and Land Area
Per Family, by Type of Dwelling

<table>
<thead>
<tr>
<th></th>
<th>Percent</th>
<th>Land Area</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Percent</td>
<td>Land Area</td>
</tr>
<tr>
<td>One family dwellings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural</td>
<td>33%</td>
<td>20,000</td>
</tr>
<tr>
<td>Urban</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Detached</td>
<td>42%</td>
<td>8,440</td>
</tr>
<tr>
<td>Semi-Detached</td>
<td>5%</td>
<td>5,849</td>
</tr>
<tr>
<td>Row</td>
<td>5%</td>
<td>3,740</td>
</tr>
<tr>
<td>Two family dwellings</td>
<td>3%</td>
<td></td>
</tr>
<tr>
<td>Detached</td>
<td>2%</td>
<td>5,840</td>
</tr>
<tr>
<td>Semi-Detached</td>
<td>1%</td>
<td>3,740</td>
</tr>
<tr>
<td>Multi-Family Dwellings</td>
<td>12%</td>
<td></td>
</tr>
<tr>
<td>3-Story Apartments</td>
<td>9%</td>
<td>2,195</td>
</tr>
<tr>
<td>6-Story Apartments</td>
<td>3%</td>
<td>1,580</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>xxx</td>
</tr>
<tr>
<td>Weighted Average</td>
<td>xxx</td>
<td>11,023</td>
</tr>
</tbody>
</table>

*Some arbitrary distribution is involved in this breakdown.*

Source: Tables 23, 24 and 25.
Residential requirements, as here calculated, do not apply to farmers, whose residential area is included in the "other land in farms" category. Assuming that 5 percent of the population will be employed and housed on farms, the factor of 0.070 acres per capita applies only to the remaining 95 percent.

For 1975, 95 percent of the projected population of thirteen and one-half million is 12.825 million, and the land requirements for residential and neighborhood use total 898 thousand acres. For 2000, with 22 million population, the 20.9 million of these not on farms will require 1,463,000 acres for residential and neighborhood use. The "ideal" plan for land use incorporates these figures.

Industrial Land Requirements

A method for determining the space requirements for manufacturing areas is described by a professor of Planning as follows:

1. Determine the salient characteristics of existing manufacturing uses in the urban area, existing industrial densities, and the prospects for future manufacturing activity as determined in previous studies of the urban economy.
2. On the basis of these studies and considering modern day industrial plant requirements, develop local standards for future industrial densities.
3. Apply industrial densities to future manufacturing employment estimates to obtain estimated land requirements.
4. Determine from summary of vacant and renewal land how supply matches up with estimated need, and, referring to location requirements, make a trail distribution into areas considered prime for industrial use, carrying over the surplus for reallocation in the vacant land tally.

---


Chapin's system is proposed as a part of city planning, so it should not be expected that the entire system would be applicable to the development of a plan for a state. Certainly the development of density standards is essential, as is the use of these standards in determination of land requirements. However, Chapin's density standards are expressed in workers per acre, which is a concept of dubious utility in this case because of difficulties involved in its use.

With density expressed on a land per worker basis, it is necessary to compute the number of workers employed in the industry in order to determine the amount of land needed. It is true that the total population, and the proportion of the population which will constitute the working force, can be estimated by projecting trends. However, the distribution of employees among the various industries and types of employment is less readily forseen, yet this information would be essential for precise application of the workers-per-acre coefficient.

The characteristics of the individual industries are also difficult to determine in advance. Current acceleration of the substitution of capital for labor in industrial production, which is under fire from labor unions decrying automation, makes it quite apparent that in the future a given volume of output will be maintained with fewer employees. Expansion of the physical plant is quite likely to occur with little or no increase in the number of employees; thus significant changes may take place in industrial density or intensity of land use for industrial purposes. The self-evident trend to low, single-floor
industrial buildings, and the migration of industry to the suburbs or rural areas to get sites for this type of structure, are evidences of these changes.

For industries as a class, changes of this nature are to be expected and reasonable allowances can be made. However, prediction of changes in density for each industry for the next 40 years, when some of the industries are as yet unborn, involves a degree of guesswork which is incompatible with the (quasi-) precision of a detailed breakdown of industries.

Existence of difficulties or barriers to precision does not preclude an attempt at development of a coefficient for industrial land use via Chapin's method. Such an attempt follows.

Chapin suggests average density values of 20 to 30 workers per gross industrial acre, pointing out that 30 was adopted and believed to be adequate for such diverse locations as Greensboro, North Carolina, Cincinnati, and the British new towns. The Cleveland Regional Planning Commission cites an average employee's density "between 15 and 25" apparently applicable to local industry. Perhaps a figure of 20 workers per acre will allow some leeway for inclusion of amenities as well as adequacy of space.

---

6Chapin, p. 308.

7Cleveland-Cuyahoga County Regional Planning Commission, Land for Industry (Cleveland: Regional Planning Commission, 1955), p. 21.
Estimates of future manufacturing employment, required by Chapin's system, can be developed by a step-down process beginning with population estimates. The steps and the assumptions utilized in this process are as follows:

a) Total population of Ohio will be as previously projected: for 1975, 13.5 million; for 2000 AD, 22 million.

b) The total labor force (persons age 14 or over) will be 70 percent of the total population.8

c) Labor force participation will be 58 percent of the total labor force.9

d) Agricultural employment will account for 5 percent of Ohio's labor force, leaving 95 percent to non-agricultural employment.10

---

8In population projections, Series II, for 1960-1980 quinquenially, the "age 14 and over" segment makes up 70.24, 70.56, 70.48, 69.83 and 69.74 percent, respectively, of the total population, for an average of 70.0 percent. Computed from U. S. Bureau of the Census, Current Population Reports, Series P-25, No. 187, quoted in Statistical Abstract: 1959, p. 6.

9Series A projections of the Labor Force Participation Rate for 1960-1980 quinquenially are 57.9, 57.7, 57.9, 58.2 and 58.6 percent; average 58.1 percent. Statistical Abstract: 1959, p. 207.

10Agricultural employment will depend upon availability of land for agricultural use; this will be determined as a residue subsequently in this study. In order to avoid two unknowns in the same equation, an assumption is necessary at this point. Farmers and farm managers accounted for 4.7 percent of employed persons in Ohio and 7.7 percent in the United States in 1950. Source: U. S. Bureau of the Census, U. S. Census of Population: 1950, Vol. II, quoted in Statistical Abstract: 1959, p. 224.
e) Manufacturing employees will be 40 percent of total non-agricultural employees.\footnote{11}

The coefficients from steps b, c, d and e (0.70, 0.50, 0.95, and 0.40) yield a product of 15.428 percent, a coefficient by which number of employees in manufacturing industry can be derived directly from the population of the state. This proportion is somewhat higher than that for Ohio in 1950 (14.99 percent) or 1958 (12.43 percent). A large part of this difference is explained by the assumptions in the component factors; more aged people increase the size of the labor force and more working women raise the participation rate. Applying this coefficient to the proper population projections, the projected number of manufacturing employees for 1975 is 2.08 million and for 2000, 3.39 million.

At the previously established rate of 20 workers per acre (or 0.50 acre per worker) the estimated requirement for industrial land for 1975 is 104,000 acres and for 2000, 170,000 acres. Industrial land, as used here, includes plant and warehouse sites and the complex of parking lots, offices, landscaped grounds, etc., usually associated with such plants, also the land for access ways and transportation requirements not otherwise provided for under urban uses or transportation land.

\footnote{11}{For the United States, this proportion was 33.4 in 1950 and 30.6 in 1958. For Ohio, comparable figures were 44.0 and 39.6; only eight states in 1950 and five in 1958 had a higher proportion of employees in manufacturing, but Ohio is expected to remain one of the leaders in industry, hence the high proportion assumed. Source of data: Bureau of Labor Statistics, Employment and Earnings, annual supplement issues, quoted in \textit{Statistical Abstract: 1952}, p. 215.}
A method alternative to that proposed by Chapin, and one in keeping with the methods used for determining land requirements for other uses, involves use of a coefficient for the amount of industrial land per unit of industrially-oriented population. It may be assumed that the entire non-farm population is in this sense industrially oriented.

Such a coefficient is not available in ready-made form, but it can be derived from available figures.

Using Bartholomew's data, the classes of light industry, heavy industry, and railroad property were aggregated as constituting the net industrial complex of land uses (Table 27). Bartholomew utilized a separate class for streets; since the divisions of land in this study used gross rather than net acreage, streets were not separated out. In order to make the classes comparable the acreage of streets must be prorated to the other uses. This has been done in Table 27, yielding a weighted average of 1.27 acres per 100 persons in the gross industrial complex of land uses.

Close scrutiny of Bartholomew's data reveals the fact that his "urban area" surveys are more nearly up to date than his surveys of "central cities" and "satellite cities," with a median date of survey of 1951 compared to 1946 and 1945, respectively. In addition, by Bartholomew's definition only the urban areas included all of the
developed land, the other communities being restricted to areas within the official boundaries. In consideration of these two facts it appears that only the urban area figure is meaningful for the purposes of this study, and even it probably should be adjusted upward to allow for the increasingly generous use of land by industry since the Korean war, the approximate median date of the surveys.

12 Bartholomew's use of the terms "urban area," "central city," and "satellite city" is sometimes confusing. In an effort to minimize this confusion, his definitions are quoted:

Three components of the can be identified: the central city, the satellite or suburban city, and the politically undefined fringe development lying between the city and the country . . . .

The term 'central city' here refers to the municipality in which is centered the major social and economic activities of an urban area. It is largely a self-sufficient city but one that may have, in recent years, attracted a sprawl of fringe developments not yet absorbed in the corporate limits of the city.

The 'satellite city' is a community adjacent to a larger municipality. While the satellite city has a separate political existence, it is in one degree or another dependent on the central city for its economic and cultural well being . . . .

The 'urban area,' on the other hand, is not a political or governmental unit but includes the central city, any satellite community, and all developed areas within the urban fringe.

Table 27

Selected Uses of Urban Land, by Type of Use, 97 American Cities at Dates Ranging from 1937 to 1952, and Computation of Net and Gross Industrial Complex of Land Uses

<table>
<thead>
<tr>
<th>Use</th>
<th>53 Central Cities</th>
<th>33 Satellite Cities</th>
<th>11 Urban Areas</th>
<th>Weighted Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light Industry</td>
<td>0.20</td>
<td>0.69</td>
<td>0.28</td>
<td>0.58</td>
</tr>
<tr>
<td>Heavy Industry</td>
<td>9.25</td>
<td>9.56</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Railroad Property</td>
<td>0.33</td>
<td>0.40</td>
<td>0.92</td>
<td>0.42</td>
</tr>
<tr>
<td>Net Industrial Complex</td>
<td>0.78</td>
<td>1.09</td>
<td>1.76</td>
<td>1.00</td>
</tr>
<tr>
<td>Total Developed Area</td>
<td>6.89</td>
<td>8.69</td>
<td>14.84</td>
<td>8.40</td>
</tr>
<tr>
<td>Streets</td>
<td>1.94</td>
<td>2.40</td>
<td>4.10</td>
<td>2.34</td>
</tr>
<tr>
<td>Streets, amount pro rated to industrial complex</td>
<td>0.22</td>
<td>0.30</td>
<td>0.49</td>
<td>0.27</td>
</tr>
<tr>
<td>Gross Industrial Complex (Including Streets)</td>
<td>1.00</td>
<td>1.39</td>
<td>2.25</td>
<td>1.27</td>
</tr>
</tbody>
</table>


A large proportion of present industrial plants are located in "pinched" sites in cities, and cannot economically move or escape because of their sunk costs. Over a period of some years the existing facilities will wear out or be depreciated, and the industry will be able to relocate.

Industrial organizations which are currently in this mobile stage are locating their new plants in peripheral areas where land is more readily available. It would appear that ultimately all of industry
will be, or at least would prefer to be, located where it has
"elbow room."

What industrial density, how much space constitutes elbow room? Referring again to Bartholomew's data, it appears axiomatic from his definitions of central cities and urban areas that industry in the central cities is pinched or limited in spatial expansion and that the portion of industry located outside the central city portion of an urban area is not pinched, with little or no limit to spatial expansion.

Some difference is likely to exist in the type of industry located in these areas, but these differences may be obscured by the apparent trend of all industries toward more extensive use of land.

A little calculation should reveal the rate of land use under "elbow room" conditions as that rate which when combined with the "pinched" rate yields the average found to exist in urban areas. If it is assumed that the spatial conditions of industry in the urban area were uniformly distributed between central city conditions (1.00 acres per 100 persons) and conditions at the expansible fringe, then in order for the whole area to average 2.25 acres per 100 persons, the rate of land use for industry at the fringe must be 3.50 acres per 100 persons. Since industry is migrating toward the fringe, the latter rate of use must represent "ideal" conditions for a point in time far enough in the future for all factors to become variable and all industries mobile.
Application of this coefficient to the total population projected for 1975 indicates that 472,000 acres of land will be needed for industrial uses; by 2000, land needs will have climbed to 770,000 acres.

Industrial land needs, as computed by this method, are more than four times as great as those computed by Chapin's method. It cannot be said that one is correct and the other incorrect; both are estimates and obviously subject to error. However, the latter method has somewhat more directness of approach and perhaps fewer assumptions regarding the characteristics of the population. Perhaps the former approach should have included all industry, or at least a larger segment than manufacturing industry alone. At any rate, the latter method with the larger figures has more safety factor. For these reasons, the "ideal" land use plan will incorporate for industrial use 472,000 acres in 1975 and 770,000 in 2000.

**Business and Commercial Uses**

Land for business and commercial purposes is analyzed by Chapin on the basis of per employee space requirements in these uses:13

- Wholesale and related uses
  - Region serving business areas
    - Regional and highway service centers
    - Central Business Districts
  - This approach would be quite appropriate if the number and distribution of employees among these segments of the economy were known for

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13 Chapin, Chapter 12.
the future. Since automation and other changes may affect both commerce and industry, but with varying effects on the different sectors, current distribution of employees is hardly an adequate basis for an ideal plan for 15 to 40 years in the future. It becomes necessary, therefore, to substitute for this measure another which is less demanding, albeit less precise.

In a study of 97 American cities and urban areas, Bartholomew found that commercial areas occupied an average of 2.98 percent of the total developed area or 0.24 acres per 100 persons. In urban areas, which included the "politically undefined fringe" around cities (see p. 160, footnote 12), commercial areas averaged more than half again as much, or 0.39 acres per 100 persons. This study was based on land use surveys dating back as far as 1935 so that recent trends in commercial establishments and their use of land could not have been adequately represented. The establishment and growth of the drive-in theatre and the expansive shopping center, to name only two examples, have come about since the earlier surveys were made. On the other hand, these per capita rates of land use are based on the population living within the developed area, while the use to which the land is put may serve a much larger population than the residents of the incorporated or built-up area. While it is evident that these two shortcomings of Bartholomew's coefficients call for adjustment, it is

14 Weighted averages of commercial areas in central cities, satellite cities and urban areas computed from Bartholomew, p. 121.
less obvious how much adjustment should be made or even in which direction.

Based on a highly subjective evaluation of the influence of several trends, a figure of 0.5 acre per 100 persons of total population is suggested. Trends considered include the increase in number of cars owned and driven to town; the resulting increase in need for off-street parking; the spectacular increase in number and size of shopping centers; the apparent willingness of "downtown" stores to fragment themselves into branches or satellite stores, the increasing similarity in mobility, shopping range and car ownership between urban and rural residents; and the trend--for whatever reason--away from extremely tall buildings even in the high value areas. If in the current battle between shopping centers and the CBD (Central Business District), centrifugal rather than centripetal force wins out, it may be that even 0.5 acre per 100 citizens is too small a coefficient for the business and commercial component of urban areas. On the basis of 0.5 acre per 100 population, 68,000 acres will be needed in 1975 and 110,000 acres in 2000 for business and commercial uses.

**Public and Semi-Public Property**

The uses of land aggregated under this heading are approximately the same as those included by some writers under alternate headings of public service facilities and regional educational and cultural facilities. The civic center, public utilities, buildings housing state and federal functions, museums, libraries, universities, medical centers, churches, cemeteries, etc., are included in this category.
In this category of land use, Bartholomew found an average of 0.75 acre per 100 persons in central cities, 0.95 acres in satellite cities and 3.75 in urban areas.\(^{15}\) This wide range would appear to indicate that the more extensive uses of land (e.g., cemeteries) are located in the fringe areas rather than within cities. The weighted average of public and semi-public property was 1.16 acres per 100 persons in Bartholomew's study. This figure is subject to the same faults, and adjustments may be based on the same trends, as previously discussed under Business and Commercial Areas. On the assumption that most, if not all, urban land use is more intensive and more cramped for space than would be ideal, an upward adjustment of this figure to 1.5 acres per 100 persons is suggested. Currently, in many cities, the approval of building permits for churches, lodge buildings and other semi-public structures requires that space be provided for off-street parking; such institutional changes as this will greatly increase the future land area in some uses. Provision for expansion is included in this coefficient by making it applicable not only to the urban population but also to the rural residents whose needs along this line must be met in urban areas.

At 1.5 acres per 100 population, 202,000 acres will be needed in 1975 and 330,000 acres in 2000 for public and semi-public property in urban areas.

\(^{15}\text{Ibid.}\)
Land Requirements for Transportation

Transportation in Ohio uses land primarily for highways and roads, for railroad trackage and rights-of-way, and for airfields and landing strips. Canals, formerly important in the transportation picture, occupied some 8,000 acres at one time but an insignificant amount now remains. The canals are now in disuse and the land is being disposed of by sale or lease.

Highways and roads accounted for about 78 percent of the land used for transportation in Ohio in 1957 (Table 28). Railroads and air transportation accounted for about 13 percent and 9 percent, respectively. While precise measurement and extrapolation of trends has not been attempted, subjective evaluation of available data leads to some pertinent conclusions.

Table 28

<table>
<thead>
<tr>
<th>Use</th>
<th>Acreage</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highway</td>
<td>541,760</td>
<td>78.3</td>
</tr>
<tr>
<td>Railroad</td>
<td>87,093</td>
<td>12.6</td>
</tr>
<tr>
<td>Air</td>
<td>62,949</td>
<td>9.1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>691,802</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

Source: Frederick R. Durr, "Transportation and Land Use in Ohio" (unpublished report of research, Department of Agricultural Economics and Rural Sociology, The Ohio State University, 1959).
1. The relocation and widening of highways and the construction of new roads such as toll roads undeniably add to the amount of land used for transportation purposes. However, land used for transportation, as measured in the study herein mentioned, included only that land used for transportation which lay outside of urban areas. Annexation of rural territory by cities and municipalities results in absorption of transportation land into the urban complex, thus reducing the (rural) transportation land.

2. Railroads have been taking up unused tracks and disposing of land with a resultant decline in railroad acreage. This decline, while not measured, probably is asymptotic, slowing to a near halt as the minimum trackage necessary for efficient operation is approached.

3. Land used for air transportation is likely to increase with some new airfields and additions to length of runways for some commercial ports. This increase will be of moderate proportions.

4. With increase in transportation land stemming from the highway construction program and airport facilities, and decrease caused by urban annexation and railroad contraction, the aggregate picture of land use for transportation purposes seems to be one of little change.

It is difficult to find a basis for projecting or predicting any substantial increase in the area of land used for transportation outside of urban areas. However, in the face of public road building programs and other known or foreseen expansion in the use of land for transportation purposes, some allowance for growth must be made. Marion Clawson concludes that the area used for transportation in the United States will increase from about 25 million acres at present to 23
million acres in 1980 and 30 million acres in 2000. This is an increase of 0.8 percent per year in the first year (to 1980) and half that much annually for the balance of the period. Perhaps a similar pattern of increase would be appropriate for Ohio: one percent per year until 1975 and one-half as much annually from 1975–2000. Using this adjustment, land used for transportation purposes in Ohio is indicated at 782 thousand acres in 1975 and 870 thousand acres in 2000.

In view of the exclusion of bodies of water over 40 acres from measurement as land, it would appear that no adjustment is needed for past or future use of navigable steams, lakes, etc. as transportation area.

Recreational Land Needs

Recreational land is a need of a different sort from that for food, clothing and shelter. However, it is still—and increasingly—a need in the sense of existence of an effective demand. People are willing to pay for the privilege of using recreational facilities including golf links, picnic grounds, bathing beaches, hunting grounds, fishing areas, camp sites, or just space in which to roam. Whether payment is by private fee or by public tax, the demand for recreational facilities appears to be increasing faster than the supply.

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To some extent, our recreational needs for land are determined by tradition and institution. A person whose childhood was spent in the city is likely to have less desire to roam the open fields than a person who experienced that pleasure as a child. Succeeding generations may require less land for extensive recreational uses and more in such intensive uses as bowling alleys, gymnasiums, etc. However, no adjustment of present indicated needs for recreational land has been attempted in this study.

Recreational land can be divided into three categories to facilitate analysis and give a clearer picture of society's needs. These three categories, as described by Clawson, are user-oriented, resource-based, and intermediate recreation areas. For the first category, accessibility is the most important characteristic. City and county parks make up most of this class. At the other extreme, for resource-based recreation areas, nearness to users counts for little; the natural scenic, historical or scientific characteristics of the site are the important qualities. The national park system and the national forests make up most of this category. In between, of course, are the intermediate recreation areas. State parks and reservoir areas are the principal lands in this category.

The amount of land from each of these categories needed by a given population has not been precisely formulated. A long-standing (since about 1923) recommendation of the National Recreation

Association calls for 10-acres per 1000 residents in cities over 10,000 with more per capita in smaller communities.\(^{18}\) This recommendation apparently applies to the user-oriented recreational lands. Barlowe mentions a proposal that the standards of the National Recreation Association "should be expanded to require 10 acres of county and metropolitan-area parks and an additional 10 acres of state and federal recreational lands (located within a two-hour drive of the central cities) for every 1,000 people in our metropolitan centers."\(^{19}\)

These recommendations do not mesh exactly with Clawson's three categories, primarily because Clawson envisioned distance or driving time as no factor in his resource-based category. However, there is a substantial acreage of national forest in Ohio, and it lies within a few hours' drive of at least part of the central cities of Ohio. Therefore, for practical purposes and for Ohio conditions, the comparability of the categories is acceptably close.

One change should be made before applying these coefficients to the expected population. The user-oriented recreation lands are primarily for the benefit of urban residents; the farm population (5 percent) and the population which is urban oriented but dwelling outside of urban areas (33 percent) will have negligible need for city and county parks. However, for intermediate and resource-based recreation lands, the farm population and the rural residents may have as much need as their urban cousins. Therefore, the coefficients for these two categories of

\(^{18}\)Barlowe, p. 98.

\(^{19}\)Ibid., p. 99.
recreation land should be applied to the entire population rather than to the urban population alone. Application of these standards for the area of recreation land indicates a need for 354 thousand acres in 1975 and 576 thousand acres in 2000.

Another approach to recreational land needs is somewhat less objective but also much closer to Ohio's conditions. V. W. Flickinger, Chief of the Division of Parks, Ohio Department of Natural Resources, cited a 400 percent increase in park attendance in the decade 1950-1960.20 The present park facilities of Ohio, Flickinger stated, are inadequate for present needs, and an immediate 100 percent increase would be no more than adequate for the existing population and its needs.

An inventory of existing Ohio recreation lands would involve the aggregation of statistics for not only state and national parks within the state but also municipal and county recreation lands and private lands available for recreational use. A partial inventory is available in the form of a list of public hunting and fishing areas with acreages of each.21 The total of land and water areas so indicated is 506,084 acres.

This acreage is largely multiple use land, being used for forestry and agriculture while also available for hunting and fishing. Of course, multiple uses should be encouraged, but to avoid double counting this

20 V. W. Flickinger, "Recreational Resources of Southeastern Ohio," paper and discussion before the Natural Resources Institute at The Ohio State University, March 7, 1960.

21 Ohio Department of Natural Resources, Division of Wildlife, "Ohio Outdoors Map" (Columbus, n.d.).
plan for allocation of land must concentrate on primary uses. The land in Ohio which is specifically allocated to recreation is 91,800 acres of state parks and 53,600 acres of municipal and county parks, or a total of 145,400 acres.\footnote{22 \textit{Statistical Abstract: 1959}, p. 194.}

Doubling of this area, indicated by Flickinger as necessary for adequacy, would result in 291 thousand acres or about 1.1 percent of the area of the state in recreational uses. Prorated among the present 9.7 million population, this amounts to 30 acres per 1,000 population which is exactly the amount already proposed (p. 171). Therefore, the acreage already computed for 1975 and 2000 (354 thousand and 576 thousand acres, respectively) will adequately meet the needs of the population for recreational land.

\textbf{Mineral and Extractive Land Use}

The amount of land which should be used for purposes of supplying minerals cannot be computed as a function of population because of the nature of the mineral deposits. Minerals must be mined where they exist. The area with a large supply of minerals must exploit them at the rate demanded by all of society, and the size of the population is only one of several factors in this demand. Existing technology and the availability of substitutes are vitally important factors.

While building stone, gravel, salt, oil, gas and clay are all locally important minerals in Ohio, the one to which the most attention is directed is coal. In a previous section (pp. 116-120), the strip
mining of coal in Ohio was discussed. In that section, it was suggested that strip mining would progress at the rate of perhaps 10 thousand acres per year until the strippable resources were depleted, which would be about the year 2000; and, at that time, perhaps 100 thousand acres would remain as a problem area without economic use. Therefore, the area of land which will be excluded from other uses by reason of its having been strip mined will be about 50 thousand acres in 1975 and 100 thousand acres in 2000.

Agricutural Land Requirements

The needs of society for land in agricultural use can be calculated by a process similar to that used to compute needs for residential, industrial and other uses. Agricultural land is needed as the source of food and of certain non-food items, principally fibers, vegetable and animal oils, and tobacco. The need for these products can be computed on a per capita basis. Production of the same products can be expressed on a per acre basis, and thus the acreage of land needed can be derived as a function of population.

What need for food should be used as the basis for allocation of land? Several alternatives present themselves: a nutritionally adequate but minimum-cost diet; a desirable diet based on an interpretation of the preferences of the populace; a diet based on maximum utilization of homegrown foods; or the diet for which consumers vote with their dollars. The last mentioned is the closest approximation to the system used to calculate other land needs in this study. But with regard to calculating agricultural production, another problem is encountered: food can be imported, or shipped across state lines.
While the population of Ohio must be housed on Ohio land, its employment provided in Ohio factory sites and its recreation in Ohio parks, its food needs can be met from the land of other states. Perhaps Ohio has no absolute and imperative need for agricultural land at all.

Theoretically the best answer to this dilemma is the principle of comparative advantage and regional specialization: let the food be raised where food production is efficient, and let industrial and other uses utilize the land—all of it if need be—where their production is efficient.

However, the projected population of Ohio for 1975 and 2000 does not project growth in Ohio at the expense of the surrounding areas, except for a small increase in the proportion of the national population in Ohio. Thus comparative advantage is built into the population projection to only a limited extent. The projected growth rate for Ohio is roughly commensurate with growth in other states. This being the case, other states will also have large populations and heavy concentrations of industrial and urban development. Importing of food is possible only if the sources have a surplus of food beyond their own needs. With proportionate development of all states, food surpluses will be available in the future only from those states which currently have surpluses.

An ideal land use plan for Ohio, therefore, dare not assume unlimited availability of food and feedstuffs from land beyond the borders of the state. As long as all the states develop at similar or proportionate rates, the availability of foodstuffs will also remain proportionate.
For these reasons the specific composition of the diet is disregarded in this study, and land requirements for Ohio in 1975 and 2000 are based on continuation of the current degree of self-sufficiency in food production.

Ohio is not self-sufficient in production of food. Self-sufficiency requires output of a proportion of national production equal to the proportion which Ohio has of the national population. The population and output and value of selected categories of agricultural production are indicated in Table 29. Only in horticultural specialities does Ohio produce more than her share; in the aggregate only about two-thirds of the requirements of agricultural self-sufficiency are produced by this state.

Dependence on outside sources of food is not necessarily undesirable. As long as development or growth of all states is proportionate, meeting the same proportion of Ohio's food needs from outside the state can and should be projected. However, this implies that Ohio produce the same proportion of her food needs in the future which she produces now. Thus the current degree of self-sufficiency and the current level of per capita requirements for agricultural land become the starting point for a projection of requirements into the future.

\[23\text{This definition of self-sufficiency ignores both the individual commodity and aggregate aspects of improving and exporting of foods, and assumes national uniformity in consumption of all food commodities.}\]
Table 29

Population, Production, Value and Degree of Self-Sufficiency for Selected Agricultural Commodities and Categories, Ohio and United States, 1958

(millions of units)

<table>
<thead>
<tr>
<th>Item and Unit</th>
<th>Ohio</th>
<th>United States</th>
<th>Ohio Percent of U. S.</th>
<th>Self-Sufficiency (percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population (estimated)</td>
<td>9.4</td>
<td>173.3</td>
<td>5.4%</td>
<td>---</td>
</tr>
<tr>
<td>Cropland, acres (1954)</td>
<td>12.3</td>
<td>459.6</td>
<td>2.8</td>
<td>---</td>
</tr>
<tr>
<td>Pasture, acres (1954)</td>
<td>6.1</td>
<td>647.1</td>
<td>0.9</td>
<td>---</td>
</tr>
<tr>
<td><strong>Production</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wheat, bushel</td>
<td>46.3</td>
<td>1462.2</td>
<td>3.2% 59%</td>
<td></td>
</tr>
<tr>
<td>Potatoes, cwt.</td>
<td>3.0</td>
<td>263.8</td>
<td>1.2% 21%</td>
<td></td>
</tr>
<tr>
<td>Vegetables, acres</td>
<td>0.1</td>
<td>3.6</td>
<td>2.0% 37%</td>
<td></td>
</tr>
<tr>
<td>Cattle and calves, cwt.</td>
<td>6.0</td>
<td>266.8</td>
<td>2.3% 44%</td>
<td></td>
</tr>
<tr>
<td>Hogs, cwt.</td>
<td>8.7</td>
<td>194.1</td>
<td>4.5% 83%</td>
<td></td>
</tr>
<tr>
<td>Sheep and lambs, cwt.</td>
<td>0.6</td>
<td>16.2</td>
<td>3.8% 70%</td>
<td></td>
</tr>
<tr>
<td>Milk, cwt.</td>
<td>53.7</td>
<td>1252.4</td>
<td>4.3% 80%</td>
<td></td>
</tr>
<tr>
<td><strong>Value</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Field crops</td>
<td>$305.2</td>
<td>$9925.1</td>
<td>3.1% 57%</td>
<td></td>
</tr>
<tr>
<td>Vegetables</td>
<td>13.7</td>
<td>845.1</td>
<td>2.1% 39%</td>
<td></td>
</tr>
<tr>
<td>Fruits and nuts</td>
<td>12.9</td>
<td>1198.0</td>
<td>1.1% 20%</td>
<td></td>
</tr>
<tr>
<td>Horticultural specialties</td>
<td>36.2</td>
<td>453.7</td>
<td>8.0% 148%</td>
<td></td>
</tr>
<tr>
<td>Dairy Products</td>
<td>149.1</td>
<td>3334.1</td>
<td>4.5% 83%</td>
<td></td>
</tr>
<tr>
<td>Poultry and P. Products</td>
<td>70.0</td>
<td>1918.9</td>
<td>3.6% 68%</td>
<td></td>
</tr>
<tr>
<td>Livestock and L.S. products</td>
<td>255.3</td>
<td>7039.4</td>
<td>3.6% 67%</td>
<td></td>
</tr>
<tr>
<td>Forest products</td>
<td>1.5</td>
<td>130.4</td>
<td>1.1% 21%</td>
<td></td>
</tr>
<tr>
<td><strong>All farm products</strong></td>
<td>$844.0</td>
<td>$24,644.7</td>
<td>3.4% 63%</td>
<td></td>
</tr>
</tbody>
</table>


Census of Agriculture: 1954.

As a first approximation, future requirements for agricultural land may be assumed to be simply and directly proportionate to population. This approach involves calculation of the current ratio between land in farms and total population of the state, and applying this ratio or coefficient to the expected future population. With 19,922 thousand acres in farms in 1955 and a population of 9,006 million, a ratio is indicated of 2.22 acres of land in farms per capita.

A refinement of this coefficient involves adjustment of the land in farms figure to remove the land which contributes little or nothing to agricultural production. Woodland is in this category; its contribution to food supply through pasturage afforded livestock is negligible. Land in farmsteads, farm roads, and lanes similarly makes only negligible contribution to food production. These uses account for 2,908 thousand and 482 thousand acres, respectively (see Table 2 and Table 5). Subtraction of this amount leaves a remainder of 16,602 thousand acres of land in crops and pasture. This is equivalent to 1.843 acres per capita.

Expected and desirable increases in the level of living necessitate adjustments in the agricultural products needed. Most of the coefficients developed have had a basis in physical optima and so are not likely to change. However, the demand for food, both in value and in agricultural requirements, historically has been subject to increase as the disposable income of consumers increases. While the mechanism of income projection involves a whole study in its own right, a summary factor may be presented as illustrative of refinements which could be made.
Various studies have measured the elasticity of demand for food. In a comprehensive study of the future supply and demand for food, Black and Maass use an income elasticity for food of +0.2, explaining: "For every 1 percent increase in disposable income per capita in the recent past, there has been an increase of 0.2 percent in the food consumption index." They project an increase in disposable income per capita of $1300 to $2000 from 1952 to 1975, or 5½ percent in 23 years (2.3 percent per year). Assuming a continuing rate of annual increase in disposable income of only 2 percent, and proportionate change in demand for food, an increase in food supplies of 0.4 percent annually will be needed to keep pace.

That the quantity of food consumed by the average human should continue to increase indefinitely is inadmissible in view of the physical limits in capacity of the human stomach. The average conceivably might rise as long as some individuals remain below the average, but when all are well and adequately fed there is no way to further increase food consumption per capita except by waste. Therefore, it seems desirable to limit the amount of increase which can be made via the elasticity approach. A convenient point at which to level off is the terminal point of Black and Maass projection, 1975. The food supplies required per capita will thus increase 0.4 percent per year until 1975 after which no increase in per capita requirements will be expected.

Table 30
Indexes of Crop Production Per Acre, United States 1919-1958 and East North Central Region 1929-1947
(1947-49=100)

<table>
<thead>
<tr>
<th>Year</th>
<th>United States</th>
<th>East North Central Region</th>
<th>Year</th>
<th>United States</th>
<th>East North Central Region</th>
</tr>
</thead>
<tbody>
<tr>
<td>1919</td>
<td>77</td>
<td></td>
<td>1940</td>
<td>88</td>
<td>89</td>
</tr>
<tr>
<td>1920</td>
<td>86</td>
<td></td>
<td>1941</td>
<td>89</td>
<td>95</td>
</tr>
<tr>
<td>1921</td>
<td>73</td>
<td></td>
<td>1942</td>
<td>99</td>
<td>99</td>
</tr>
<tr>
<td>1922</td>
<td>79</td>
<td></td>
<td>1943</td>
<td>91</td>
<td>90</td>
</tr>
<tr>
<td>1923</td>
<td>79</td>
<td></td>
<td>1944</td>
<td>96</td>
<td>88</td>
</tr>
<tr>
<td>1924</td>
<td>79</td>
<td></td>
<td>1945</td>
<td>95</td>
<td>96</td>
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<tr>
<td>1925</td>
<td>80</td>
<td></td>
<td>1946</td>
<td>101</td>
<td>100</td>
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<tr>
<td>1926</td>
<td>82</td>
<td></td>
<td>1947</td>
<td>95</td>
<td>87</td>
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<td>1927</td>
<td>81</td>
<td></td>
<td>1948</td>
<td>106</td>
<td>108</td>
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<td>1928</td>
<td>83</td>
<td>75</td>
<td>1949</td>
<td>99</td>
<td>105</td>
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<tr>
<td>1929</td>
<td>79</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>1930</td>
<td>75</td>
<td>68</td>
<td>1950</td>
<td>97</td>
<td>101</td>
</tr>
<tr>
<td>1931</td>
<td>83</td>
<td>85</td>
<td>1951</td>
<td>98</td>
<td>104</td>
</tr>
<tr>
<td>1932</td>
<td>79</td>
<td>84</td>
<td>1952</td>
<td>103</td>
<td>107</td>
</tr>
<tr>
<td>1933</td>
<td>71</td>
<td>67</td>
<td>1953</td>
<td>103</td>
<td>108</td>
</tr>
<tr>
<td>1934</td>
<td>59</td>
<td>61</td>
<td>1954</td>
<td>101</td>
<td>109</td>
</tr>
<tr>
<td>1935</td>
<td>76</td>
<td>84</td>
<td>1955</td>
<td>106</td>
<td>115</td>
</tr>
<tr>
<td>1936</td>
<td>65</td>
<td>66</td>
<td>1956</td>
<td>109</td>
<td>125</td>
</tr>
<tr>
<td>1937</td>
<td>88</td>
<td>90</td>
<td>1957</td>
<td>112</td>
<td>115</td>
</tr>
<tr>
<td>1938</td>
<td>85</td>
<td>90</td>
<td>1958</td>
<td>124</td>
<td></td>
</tr>
<tr>
<td>1939</td>
<td>85</td>
<td>95</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


Further adjustment is desirable to correct for the trend toward greater unit productivity resulting from better management, more intensive application of other resources (fertilizer, irrigation, machinery and equipment, improved seed), amelioration of the land itself (surface and sub-surface drainage, lime), and advances in technology which
may not be readily classified under any of these headings. The index of crop production per acre in the United States, using 1947-49 as a base period, has climbed from 77 in 1919 to 122 in 1958 (see Table 29). The five-year averages on each end are 78.8 for 1919-1923 and 110.2 for 1954-58. The increase of 31.4 percentage points between midpoints of the 5-year periods (35 years apart) is nearly one percent per year.

The East North Central Region, of which Ohio is a part, has had even more increase in yield of crops. The similar index of crop production for this region rose from a 5-year average of 75.8 for 1929-33 to 114.4 for 1953-57, an increase of 38.6 percentage points in 25 years between midpoints of the 5-year periods. Thus, this region has increased production per acre at the rate of 1.5 percent per year.

There are hazards involved in projecting a rate of increase such as this. Achievement of this increase or technological advance in the past has involved the discoveries and inventions by scientists and engineers, dissemination of the information through various imperfect channels, acceptance of the new knowledge and willingness to use it on the part of the farmer, and economic or price relationships which make it profitable for him to do so. While the maximum output possible has thus been increased for many crops, a high proportion of the increase in the index or average has come about because all producers are nearer their maximums. A J-shaped distribution may be achieved, wherein the mean cannot be raised much more because it approaches the limits of production. Because of the multiple uncertainties involved, some discounting of the historical rate of technological advance is desirable.
from the viewpoint of a cautious and conservative outlook. However, in order to project as much increase as can be justified on historical grounds, a rate of increase of 1.5 percent per year is used.\footnote{25}

Implicitly this projection assumes that increases in crop output per acre are indicative of advances in all agricultural production. Nationally, increases in output per breeding unit have been somewhat greater than increases in crop yields. Efficiency of conversion of feed to animal product also influences the total rate of advance in production efficiency.

The need for crop and pasture land in 1975 and 2000 can be computed from the foregoing figures. The crop yield index will have increased at 1.5 percent per year to 130 percent of 1955 by 1975 and to 167.5 percent in 2000, so that the acreage required for the same production will be 76.9 percent of 1955 in 1975 and 59.7 percent in 2000. Per capita consumption which required 1.843 acres in agricultural production in 1955 will have increased by 8 percent (0.4 annually for 20 years) by 1975 and is assumed to level off there, so that for both 1975 and 2000 production equivalent to 1.99 acres per capita will be needed. Because of higher yields, this production can be obtained from 1.530 acres per capita in 1975 and from 1.188 acres per capita in 2000. The aggregate

\footnote{25A simple interest concept, rather than the theoretically preferable and more precise compound interest concept, is used here. In view of the imprecision and uncertainties involved in determining the rate of technological advance, the gain in precision with the compound interest concept does not justify the complexities of its calculation.}
need for land in crops and pasture will be 20.655 million acres in 1975 (13.5 million population) and 26.136 million acres in 2000 (22 million population).

In addition to land for production of crops and pasture, there is inevitably a certain amount of land for overhead and administrative purposes: building sites, farm roads, lanes and miscellaneous non-productive farm uses. This segment of land in farms was removed for calculation of per capita needs, for there is no reason why it should increase in proportion to population. With a trend to larger farms some reduction might be made here, but if agriculture were intensified such gains would be reduced or eliminated. Therefore, the amount of land needed for farm buildings, lanes and allied uses is projected at the current amount, 482 thousand acres.

Forest Land Requirements

In 1800 the territory included within the present boundaries of Ohio was practically an unbroken forest. To the aborigines, the forest was the source of the wild game which provided food, clothing and to some extent shelter. Civilized man is dependent upon the forests for a much smaller proportion of his needs and has in consequence eliminated some 80 percent of the forests originally in Ohio. However, forest products still constitute an important segment of the needs of society. In this section an "ideal" plan is developed for the allocation of land to forestry in Ohio.

A rather comprehensive study of the need for forest products on the national level has been performed by the Forest Service. The report of this study, Timber Resources for America's Future,\(^27\) contains much detailed information on the probable demand for different types and classes of forest products, the current inventory of growing stock, and the rate at which growth is occurring. A segment of the summary data regarding demand is presented in Table 30. For the eastern species groups, needed growth is indicated as exceeding 1952 growth for both saw timber and growing stock, except that eastern hardwoods will not be in short supply until some time after 1975. Undoubtedly technological advance and the application of better management practices can improve the efficiency of harvest and utilization of forest products, reducing the amount of growth needed to meet a given level of demand. Nevertheless, a need for increase in the land area allocated to forest production can be inferred from these data.

<table>
<thead>
<tr>
<th>Species Groups</th>
<th>Billion Board Feet</th>
<th>Change from 1952</th>
<th></th>
<th>Billion Board Feet</th>
<th>Change from 1952</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Eastern Hardwoods</td>
<td>18.3</td>
<td>29.1</td>
<td>-4</td>
<td>+52</td>
<td>4.5</td>
<td>7.3</td>
</tr>
<tr>
<td>Eastern Softwoods</td>
<td>28.2</td>
<td>43.1</td>
<td>+66</td>
<td>+154</td>
<td>5.7</td>
<td>8.3</td>
</tr>
<tr>
<td>Western Species</td>
<td>21.7</td>
<td>33.2</td>
<td>+92</td>
<td>+194</td>
<td>4.4</td>
<td>6.4</td>
</tr>
<tr>
<td>All Species</td>
<td>68.2</td>
<td>105.4</td>
<td>+44</td>
<td>+122</td>
<td>14.6</td>
<td>22.0</td>
</tr>
</tbody>
</table>

Use of land for forestry is an extensive use, requiring small inputs of other resources. Land of low economic use capacity is, therefore, best adapted to forestry. Where competition for land exists the more intensive uses can and will out-compete forestry. The resulting diminished proportion of total land resource allocated to forestry will result in higher prices for lumber and other forestry products, and other materials will be substituted for those derived from trees. For these reasons, precise quantification of the demand for forest products or computation of the land area required for production of those quantities is of little help in developing an "ideal" land use program for Ohio. A more fruitful approach is via inventory of the biological use capacity of Ohio's land, with direct assignment to forest uses of that land which is better adapted to forestry than to other uses.

It may be argued that a similar approach to agricultural land should be used, since food products from outside the state can substitute for native production. However, nothing can substitute for food. Steel, aluminum, stone, and concrete can replace lumber as a structural material; processed cornstalks, plastics, and various metallic and mineral materials can substitute as sheathing. No use of wood is known to exist which cannot be performed by substitutes for wood. But food is irreplaceable, and it is on this basis that agricultural land is calculated as a primary rather than a residual need in this study.

The land use capacity approach is followed in this study to determine the place of forest land in Ohio. The soil inventory data of the
Conservation Needs Inventory Committee shows the use of the land by counties and by capability classes. This "ideal" plan is developed for points from 15 to 40 years in the future, and it may be assumed that the fixed costs of any use of land will become variable within that period. Therefore, the use of land in 1975 and 2000 is assumed to depend altogether on the capability of the land, disregarding its current use.

Summary of the CN soils inventory shows that 1.54 million acres of land in Ohio are of capability Class VI and 2.067 million acres are of Class VII. While some forests will occur even in 1975 and 2000 on patches of land of higher capability than VI and VII, there will be compensating patches of land in these classes in non-forest use. Classes VI and VII are adapted to either pasture or woodland (see discussion of characteristics of the capability classes in Appendix A). It is assumed in this study that because of the topographic problems all of Class VII will be used for forestry. Whether Class VI land has the economic use capacity to be profitable as pasture land under 1975 and 2000 conditions, or whether it should also be in forests, is dependent on agronomic and forestry input-output relationship and cost-price relationships about which not enough is known to justify a flat prediction. Therefore, a compromise is suggested, that half of the Class VI land be allocated to forestry and half to pasture and other uses. This flexibility will permit some geographic adjustments; where agriculture is fairly intensive, all of the Class VI land can be used for grazing; where there is little agriculture all of it can be forested.
Use of these proportions (all of Class VII plus one-half of Class VI) indicates that the total land so allocated to forestry and woodland uses will be 2,837,000 acres in both 1975 and 2000.

**Aggregation of Ohio Land Needs**

The amounts of land needed to fulfill the various requirements of the population projected for Ohio in 1975 and 2000 have been computed for the individual needs or uses of land. In order to regain perspective it is necessary to combine these "ideal" components into an aggregative picture of land use for the state. This aggregation is presented in Table 31.

A very obvious conclusion which can be drawn from this table is that the amount of land in Ohio approximates that required to fulfill the needs of the population projected for the state in 1975, but it is short of the needs projected for 2000. In other words, Ohio will not be big enough for all the people who are expected to crowd into it between 1975 and 2000.

The magnitude of the deficiency of land in 1975 is negligible, but it rises rapidly thereafter. In 2000 only about 70 percent enough land is available in Ohio to meet the "ideal" needs of the population projected for that year. Yet Ohio's area is fixed; her boundaries are not subject to expansion. If there are that many people in Ohio, deviation from the ideal man-land ratio is inevitable. The assumptions regarding population preclude formulation of an ideal land use plan for 2000; a plan for 22 million people in Ohio simply cannot incorporate ideal per capita rates of land use. In formulation of the land use components, there has been little concept of rationing of a limited resource.
Table 32
Aggregated Land Needs for Ohio in 1975 and 2000
(thousands of acres)

<table>
<thead>
<tr>
<th>Land Use</th>
<th>1975</th>
<th>2000</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Urban Uses</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residential and Neighborhood Areas</td>
<td>898</td>
<td>1,463</td>
</tr>
<tr>
<td>Industrial Land</td>
<td>472</td>
<td>770</td>
</tr>
<tr>
<td>Business and Commercial Areas</td>
<td>68</td>
<td>110</td>
</tr>
<tr>
<td>Public and Semi-Public Property</td>
<td>202</td>
<td>330</td>
</tr>
<tr>
<td><strong>Total of Urban Uses</strong></td>
<td>1,640</td>
<td>2,673</td>
</tr>
<tr>
<td><strong>Transportation Use</strong></td>
<td>782</td>
<td>870</td>
</tr>
<tr>
<td><strong>Recreational Areas</strong></td>
<td>354</td>
<td>576</td>
</tr>
<tr>
<td><strong>Mineral and Extractive Use</strong></td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td><strong>Crop and Pasture Land</strong></td>
<td>20,655</td>
<td>26,136</td>
</tr>
<tr>
<td><strong>Farm buildings, Lanes and Allied Use</strong></td>
<td>482</td>
<td>482</td>
</tr>
<tr>
<td><strong>Forests</strong></td>
<td>2,837</td>
<td>2,837</td>
</tr>
<tr>
<td><strong>Total of All Uses</strong></td>
<td>26,800</td>
<td>33,674</td>
</tr>
<tr>
<td><strong>Total Area of Ohio</strong></td>
<td>26,240</td>
<td>26,240</td>
</tr>
</tbody>
</table>

Ideal land use has been a concept comparable to an ideal diet, with purchasing power and availability of the diet ignored. The cold, hard fact of limitation on land is incompatible with such a concept of ideal land use.

Adjustment or reconciliation of the difference between "ideal" needs as herein developed and the limit of 26.25 million acres in Ohio may be achieved or attempted by several alternative methods. These alternatives will be examined and discussed in the next chapter.
CHAPTER V
EVALUATION OF PROJECTED AND IDEAL LAND USE

At the outset of Chapter IV, the formulation of an ideal land use plan was undertaken to meet the need for a criterion in the evaluation of evolving patterns or trends. The foundation for this ideal plan was a population projection, to which could be applied per capita rates of land use. Subsequently, this foundation was found to be incompatible with the concept of ideal rates of land use, because insufficient land exists in the state to fulfill ideal needs for the projected population after about 1975. This insufficiency arises because of the assumption that the same proportion of per capita food needs will be met from Ohio agriculture.

Since ideal rates of land use for various purposes cannot be aggregated into a usable criterion or standard, the task remains of forging a compromise land use plan to serve as a criterion. Such a plan will be less than ideal, but perhaps some of the ideal features can be salvaged.

Reconciliation: An Adjusted Land Use Plan

The ideal land needs can be reconciled or adjusted to the total of available land area by two approaches, a pro rata system and a priority system. A pro rata system diminished the amount of land in each use in the same proportion. Underlying theory for this type of adjustment is that the input-output relationships for land follow the same shape
of curve in each use to which land is put. Therefore, proportionate diminution of input must result in proportionate reduction of output, so that the relative profitability of the various uses is unchanged.

The priority system involves arraying or ranking the uses of land and allocating sufficient land to satiate the needs of the high-priority uses before any land goes to the uses of lower priority. In actuality or in theory this concept is much less clear-cut than in this oversimplified summary. Certain uses of land normally have response curves which justify allocation of much land to these uses without precise determination of marginal returns. More land may be allocated to a given use than can be economically justified, and those planning the allocation of land resources may be surprised to find that some other use is more remunerative. Thus, the free market mechanism of allocating land results in something approximating a priority system, because of imperfect knowledge of opportunity costs for other uses of land.

As a means of reconciling the needs and the available land, prorating has some theoretical strength, but it encounters practical difficulties. Prorating would reduce each component of ideal needs by 2.1 percent for 1975 and by 22.1 percent for 2000. However, some of these components are not amenable to diminution by either a pro rata or a priority system. Transportation use of land, for example, is hardly likely to be reduced between 1975 and 2000. Only a small expansion has been planned, but the marginal value of this expansion is high. The essential nature of transportation and the high fixed costs in roadbeds, air terminals and other transportation facilities effectively preclude reversion of transportation land to other uses. Land used for farm
buildings, lanes, etc., is similar in concept; neither fixed costs nor the inherent suitability of the land favor reversion to other use. Besides, this use is essential to agricultural production. Mineral and extractive use land was determined as the aftermath of the stripmining process. Trends in stripmining are not closely related to population, and the acreage of unreclaimable spoil banks cannot be diminished by simple prorating. Forest land was established on the basis of biological capability or lack of potentiality for other uses. Land which is not adapted to other uses cannot be made adaptable by prorating. Thus, it appears that the amounts of land in the transportation, mineral, farm buildings and forest categories cannot be significantly reduced without overhauling the basic assumptions upon which allocations for these uses were made. The total area of land needs for these irreducible uses is 4.151 million acres in 1975 and 4.289 million acres in 2000. This leaves a residue of 22.089 million and 21.951 million acres in 1975 and 2000, respectively, for allocation to all the other uses. Needs to be met from these amounts of land total 22.649 million acres and 29.385 million acres in 1975 and 2000.

The concept of highest and best use gives a basis for establishing priorities among the remaining uses of land. The customary array, illustrated in Figure 5, places urban land in highest position, with cropland and pasture lowest of these needs remaining to be met. Allocation of the remaining land on this priority basis yields the land pattern presented in Table 33.

The customary array of highest and best uses previously referred to may not be applicable in every case. Under conditions of extreme
food shortage that appear likely to develop under the assumption that the same proportion of Ohio food needs will be met from Ohio agriculture, and with a limited supply of land suited for food production, use for food production might be expected to out-compete all other uses for the highly favored land. In such a situation, admittedly, applicable to only the best land and in circumstances which now seem far-fetched, the highest and best use of land would be food production rather than industrial and other urban uses. The last column in Table 33 shows land use as it would be allocated in 2000 following a shift in highest and best use in 1975 so that, except for minor changes in the irreducible items (indicated*), the land use pattern of 1975 is in effect frozen. While the urban and industrial complex of uses would be prevented from making further inroads on agricultural land, the shortage would continue to grow more constrictive because of continued population increases.

The compromise land use plan presented in Table 33 does not imply that all problems of land use are solved, but merely that a compromise has been established so a criterion for evaluation of emerging trends and patterns. The deficit of crop and pasture land remains a problem. Although hardly serious for 1975, the deficit for 2000 represents an unfilled gap which must be closed if the assumed population, the desirable diet, and the same degree of state self-sufficiency are all to be realized.
Table 33

Adjusted Land Use Plans for Ohio in 1975 and 2000

(Thousands of acres)

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Compromise Land Use Plan (Agriculture as a Residual Claimant)</th>
<th>Agriculture as Highest and Best Use Beginning 1975</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1975</td>
<td>2000</td>
</tr>
<tr>
<td>Urban Uses:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residential and Neighborhood Areas</td>
<td>898</td>
<td>1,463</td>
</tr>
<tr>
<td>Industrial Land</td>
<td>472</td>
<td>770</td>
</tr>
<tr>
<td>Business and commercial Areas</td>
<td>68</td>
<td>110</td>
</tr>
<tr>
<td>Public and Semi-Public Property</td>
<td>202</td>
<td>330</td>
</tr>
<tr>
<td>Total of Urban Uses</td>
<td>1,640</td>
<td>2,673</td>
</tr>
<tr>
<td>Transportation Use</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recreational Areas</td>
<td>782*</td>
<td>870*</td>
</tr>
<tr>
<td>Mineral and Extractive Use</td>
<td>354</td>
<td>576</td>
</tr>
<tr>
<td>Crops and Pasture Land</td>
<td>50*</td>
<td>100*</td>
</tr>
<tr>
<td>Farm Buildings, Lanes, etc.</td>
<td>20,095</td>
<td>18,702</td>
</tr>
<tr>
<td>Forests</td>
<td>482*</td>
<td>482*</td>
</tr>
<tr>
<td>Total of All Uses</td>
<td>26,240</td>
<td>26,240</td>
</tr>
<tr>
<td>Deficit of Crop and Pasture Land$^b$</td>
<td>560</td>
<td>7,434</td>
</tr>
<tr>
<td>Deficit of Urban and Recreational Land$^b$</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

$^a$Items marked * were not subject to diminution.

$^b$Deficit relative to needs indicated in Table 32.

Source: Table 32 and calculations.
Will There Be Enough Land?

Since only moderate diminution of crop and pasture land after 1975 is indicated in the compromise land use plan, the question may be raised as to the possibility that advances in technology will be sufficient to compensate for the loss of land. Expected loss of land is about 0.7 percent annually from the 1975 base. The popularity of the technological revolution and the glib acceptance by many individuals of technology as the answer to any and all problems justifies some examination of the prospects for sufficiency of agricultural land.

The "ideal" land needs were computed on the basis of gain in output per acre averaging one and one-half percent per year. The compromise plan reduces agricultural land below the indicated needs. What rate of increase in technology would be needed to offset this reduction and at the same time keep up with population increase? In order to make the same proportionate contribution to the sustenance of 13.5 million people in 1975 and 22 million in 2000 as was made for 9 million in 1955, in spite of the restrictions imposed on acreage by the compromise land use plan, the index of agricultural productivity would have to increase from a base of 100 in 1955 to 134 in 1975, and 234 in 2000. To achieve this, the annual increase in crop yields would need to be stepped up from the 1.5 percent used in the projection to 1.7 percent annually to 1975. This moderate additional demand on technology seems capable of achievement, and if realized would result in needs being met in 1975. However, the increase necessary between 1975 and 2000 to produce the needed increase in food supplies from a declining area base amounts to 100 index points in 25 years or 4 percent per year. Only 4 times in 29
years has the crop yield index for the East North Central Region gone up by four or more points two consecutive years, and in every one of these cases most or all of the ground gained was lost within a year or two (see Table 30). A sustained rate of improvement of 4 percent per year, which means doubling yields in 25 years and trebling in 50, simply does not appear to be within the reach of agriculture at this time.

This pessimism with respect to adequacy of land for agriculture and consequently of food for the human race hearkens back to the doctrines of T. R. Malthus. The teachings of "the gloomy parson" have been ridiculed, but his ghost will not lie still. Even the United States Department of Agriculture has recently published research findings which indicate that a shortage of land is not only inevitable but foreseeable.

"A 50-Year Look Ahead at U. S. Agriculture"¹ projects the need for new cropland under probable combinations of level of population, levels of crop yields and level of exports for the nation as a whole. With a high population projection (440 million by 2010), crop yields resulting from full, efficient economic application of available technology (with prices at about the 1951-53 level), and the export level of 1956, as much as 230 million acres of additional cropland would be needed by 2010. This would require all of the remaining land in continental United States, including Alaska, now classified as suitable for

cultivation. The median set of projections, indicated by this report as more probable of occurrence than the high level, requires 122 million more acres of cropland, 25 million acres to replace land taken up by urban and other uses, and 97 million acres of net increase.

If we assume that Ohio's population comprises 6 percent of the national total and that the same proportion be available to Ohio of the output of the 122 million acres needed, Ohio would receive the output equivalent of 7.3 million acres addition to her cropland. Together with the 18.7 million acres shown in the compromise land use plan for 2000, the output equivalent for Ohio is indicated at 26 million acres. Compared to that 26.1 million acres in the ideal land use plan, a good degree of similarity is seen between the projected needs in this study and those of the recent U.S.D.A. report.

Another report prepared by the Department of Agriculture for a Senate Committee (the Kerr Report) draws comparable conclusions:

For the low level of population projections, the increase in yields . . . . comes close to meeting requirements . . . .

For the medium level population projections . . . . more land and water development or other means of increasing output would be needed.

When the high level of population projections are considered the combined effects of increased requirements for farm products and the increased nonfarm uses of land become even more striking . . . . Increased emphasis on . . . methods of increasing output would be needed to meet these estimates of the requirements in 1980. The increases estimated in this report from the various land and water development measures alone would fall short of meeting high requirements in 2000.  

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While there is no general agreement that a scarcity of land for agriculture is imminent, the possibility of such a scarcity, and its logical inevitability under certain assumed conditions, make it desirable that the alternative solutions or approaches to solution of the problem be investigated. This will be undertaken in a subsequent section.

Comparison: Projected Land Use and the Compromise Plan

The same problem of non-comparability of statistical data which earlier hampered comparison between projection of trends and estimates by the Conservation Needs Committee is again a problem at this stage. In the computation of ideal needs in Chapter IV, the breakdown of land uses was somewhat different from that used by either the Census Bureau or the CN Committee. This was necessary because of the categories of land use in common usage among planners, for which data were available.

The result is that only an incomplete and tenuous basis for evaluation can be presented in Table 34. In this table, the present (1955) inventory is taken from a study designed to be comparable to census data. These data constitute a picture much more comparable to the planning categories than can be obtained from census data or from projections based on census data. For the projections a process of arbitrary aggregation and calculation of residues is necessary in order to derive broad categories with general comparability. While the low degree of comparability is a disadvantage in analysis, significant observations can be made.
Table 34
Present and Projected Land Use and Compromise Plan for Land Use in Ohio, 1955, 1975 and 2000
(Thousands of acres)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>26,240</td>
<td>26,240</td>
<td>26,240</td>
<td>26,240</td>
</tr>
<tr>
<td>Crops and Pasture</td>
<td>16,063</td>
<td>16,190&lt;sup&gt;a&lt;/sup&gt;</td>
<td>14,404&lt;sup&gt;a&lt;/sup&gt;</td>
<td>20,095</td>
</tr>
<tr>
<td>Farm Buildings, Lanes, etc.</td>
<td>482</td>
<td>16,190&lt;sup&gt;a&lt;/sup&gt;</td>
<td>14,404&lt;sup&gt;a&lt;/sup&gt;</td>
<td>482</td>
</tr>
<tr>
<td>Forests</td>
<td>5,396</td>
<td>2,667&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2,447&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2,837</td>
</tr>
<tr>
<td>Other Rural Uses</td>
<td>114</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All Urban Uses</td>
<td>1,006</td>
<td>1,640</td>
<td>2,673</td>
<td></td>
</tr>
<tr>
<td>Transportation Use</td>
<td>520</td>
<td>782</td>
<td>870</td>
<td></td>
</tr>
<tr>
<td>Recreation Land</td>
<td>92</td>
<td>354</td>
<td>576</td>
<td></td>
</tr>
<tr>
<td>Mineral and Extractive Use</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Miscellaneous Other Land</td>
<td>2,567</td>
<td></td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>4,185</td>
<td>7,383</td>
<td>9,389</td>
<td>2,826</td>
</tr>
</tbody>
</table>

<sup>a</sup>Computed as a residue.

<sup>b</sup>Woodland in farms only.

Source: Tables 2 and 33.
Ideally, trends projected to indicate future land use should point toward the standard or objective of a desirable pattern for some future point in time. However, the trends projected from census data do not indicate achievement of the compromise plan for land use. The trend goes the wrong way.

The compromise plan for land use, giving highest priority to urban uses, and using what seemed to be liberal rates of land use, indicates a need for non-farm land in 2000 virtually identical with the amount of non-farm land in 1955. Urban uses in 1955, when the population was about 9 million, had already superseded agricultural or biological uses on as much land as the 22 million population in 2000 would have need for. If trends are realized, much more than twice as much land will be withdrawn from agricultural uses as the compromise plan shows need for.

Such gross discrepancy between expected use and a reasonable standard for use indicates that either the standard was established in error, or the use of urban and non-farm land is exceedingly wasteful. The weight of evidence appears to be on the side of waste.

Much of the land within the corporation limits or the bounds of influence of any large city is vacant land. Urban development characteristically leaps over and engulfs areas of land which are unused and undeveloped for urban purposes not only at the time of engulfment but for long periods afterwards. However, agricultural use of this land usually ceases because the inefficiencies of farming fragmented tracts, the higher taxes, and the uncertainty of tenure result in prohibitively high costs for agricultural production.
Some indication of the magnitude of the vacant land problem is to be found in the number of vacant lots. Of locally assessed taxable real properties in 1956 in the United States, 20.8 percent were vacant lots. For Ohio, 29.2 percent were vacant lots. The value of these lots is small; for Ohio, 2.9 percent of the value of all real property lay in vacant lots. The extent of the area is not revealed by these data, but on the reasonable assumption that vacant lots are the same average size as other non-farm properties, vacant lots may have occupied as much as one-third of the non-farm area in Ohio in 1955. While it is reasonable to expect that ultimately most or all of the vacant lots and engulfed areas will be put to some more intensive use than "ripening" and awaiting development, the vacant land problem does not by this means solve itself. More land is engulfed at the periphery of urban development, and the time lag between engulfment and ultimate development may be a generation or more. The premature subdivisions of the land boom of the 1920's led to varying degrees of encirclement or engulfment of land, some of which is still vacant.

From the standpoint of agriculture and the problem of sufficiency of land, the question relative to vacant city lots is this: Can society afford to withdraw land from agricultural use for a generation of idleness and disuse? In view of current agricultural programs which have as their objective the withdrawal and idling of large

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amounts of agricultural land, the answer to this question must be yes, society can afford it. A society as wealthy in both resources and produced goods as the United States can afford "ripening" land at present, just as she has been able to afford it in the past.

Except for brief periods since an American agricultural economy came into being, it has had a surplus for export. Production of crops in excess of domestic demand is one of the most outstanding characteristics of agriculture in the United States today. With a "head start" in the form of stocks stored by the Commodity Credit Corporation, and with a backlog of technology and know-how which if fully utilized would increase yields and add to already overwhelming surpluses, American agriculture bids fair to keep supply ahead of demand (at the desired price) for some time to come. Ironically, it is with a note of sadness, almost tragedy, that the announcement is made that it will be several years before the upsurging population can "eat our way out from under the surpluses."

Prospects are for a continuation, for several years, of a level of prices at which agricultural uses of land are unable to resist the competition of other uses. Until such time as the surpluses of agricultural products diminish, and the prices received by farmers improve relative to costs, little improvement can be expected in the bargaining power of agriculture for the use of specific tracts of land. It will be some time, therefore, before the extensive margins of agricultural use of land undergoes any noteworthy extension. Land which has been retired from agriculture will be brought back into use if it is adapted
to profitable production of crops. But the price relationships which make possible a profit do not appear likely to develop in the near future.

The need for more land in agriculture will come about eventually. When this happens the land now surplus for agriculture should again be used for agriculture. Wise use of this land in the intervening period is necessary if maximum interim benefits are to be derived while retaining some freedom of choice as to the use of the land later on.

Charles E. Kellogg of the Soil Conservation Service, Department of Agriculture, expresses fears along this line. There is no problem of scarcity or shortage of agricultural land at present, he says, but society must exercise caution lest the land currently surplus be put in uses from which it cannot economically be recalled to agricultural use, when it is needed—as it will eventually be needed—for food production.

One more comparison of projected trends and the compromise plan needs to be made. The rate at which crop yields would need to increase has been discussed with respect to keeping pace with increase in population and the decline in agricultural land envisioned in the compromise plan (pp. 195-196). What rate of increase in yield index would be necessary to assure adequacy of food production from the acreage likely to be available, as indicated by projection of trends? With 16.2 million acres in crop and pasture land in 1975 and 13.5 million people, an index of 166 percent of 1955 would be needed. For 2000, with only 14.4

4 Charles E. Kellogg, Soil Conservation Service, U. S. Department of Agriculture, Comments at the seminar on "Dynamics of Land Use: Needed Adjustment" held at Iowa State University, Ames, Iowa on May 3-5, 1960.
million acres and 22 million people, an index of 304 percent of 1955 would be required. The former represents an average increase in crop yields of 3.3 percent per year, while the latter represents 4.5 percent increase each year starting in 1955, or 3.3 percent from 1955 to 1975 and 5.5 percent annual increase starting in 1975. What has been said earlier regarding the foolhardy optimism necessary to expect and depend upon such rates of increase applies severalfold at this point.

Possible Approaches Toward Solution

Looking to the long-run conflict between the growth of population and demand for food on the one hand, and limited land resources from which to produce food on the other hand, several approaches toward solution are available. These will be briefly discussed.

More and faster technological advance is one possibility with wide appeal. The algaeculturists and the food-factory proponents represent the extreme point of view, while a natural human optimism underlies expectation of some improvement in yields. Even if the apparently asymptotic nature of increases in biological output is disregarded, the magnitude of advances necessary to cope with the problem would appear sufficient to discourage all but the most visionary. Whatever gains are possible along this line, inadequate though they may be, should be exploited to the limit. In spite of a temporary surfeit of agricultural production, research should be continued or expanded. All possible knowledge, skill and technology will be needed at a date not
too far distant. A belated "crash program" of research would have little chance of compensating for lost years.

Importing of food from other areas of the nation or from other nations offers promise only insofar as the economic development of a food-deficit area is not paralleled within the market area. If other similar deficit areas also require additional agricultural products, importing will be impossible because of lack of available supplies. Rapid economic development, increases in population, and shifts of agricultural land to non-food-producing uses are anticipated as being widespread characteristics of the national and world-wide picture in 1975 and 2000. Under these circumstances importing of food would solve the food deficiency problem in one area only to intensify it in another area, and the net gain to the aggregative society would be nil.

Intensification of agriculture may come about through greater inputs of known technology, made possible by higher food prices or by lower input costs. Intensification in Ohio's agriculture may also come about by shifts to more intensive crops and livestock enterprises, such as the shift from cereal production to potato raising or the replacement of beef cattle by dairy cattle. This type of intensification would necessitate a change in the diet, unless accompanied by compensating shifts from potatoes to cereals or from dairy to beef in other states. Without such shifts in diet the advantage to society would be primarily some cost reduction due to regional specialization. Important shifts in regional types of farming have already taken place, and further increases in production or further decrease in costs due to regional specialization appear unlikely to occur.
Change in diet offers possibility for large reductions in the conflict between amount of food and number of people. Two types of changes are possible. Fewer calories may be consumed—a quantitative reduction. Lower quality of food, or food items of which per acre output is high, may be substituted for luxury-type foods. More cereals, beans, and potatoes in the diet would permit the feeding of many more people from a given quantity of land resource than a diet emphasizing meat, fresh vegetables, and dairy products. A nutritionally adequate diet can be produced with only a small proportion of livestock products, reducing the loss from conversion by animals. Continuation of the trends in replacement of human energy by machines would permit sizeable reduction in per capita calorie requirements, in addition to the reduction possible in the excess of intake over needs. These changes in diet involve changes in the level of living, but so to some extent do all of these approaches to adjustment. The idea of substituting beans for beefsteak, however, strikes the average American in a vulnerable spot: this is one reduction in level of living which will be opposed.

Reallocation of land among the various uses would permit expansion of some previously restricted uses, at the expense of other uses previously less restricted. This approach, in short, constitutes allocation of land uses in accordance with a plan for efficient use to maximize the goals of society. Other plans than the one developed in this study can be drawn, and their recommendations will vary depending upon their assumptions as to population, technological advance, price levels, social factors, and other elements of the physical, economic, and institutional frameworks of land use. But it appears that almost any
such plan will find it necessary to modify the pattern of land use which is emerging. The wastefulness of modern society's use of non-farm land is scandalous. The inadequacy of agricultural land that appears likely to develop by 1975 or shortly thereafter must somehow be avoided. If this is to be accomplished, land of the highest agricultural potential should be held for food production rather than being permitted to go into industrial, residential and other largely irreversible uses, wherever it is economically feasible to shift these uses to land of lower agricultural value. Some development of new land by drainage, irrigation, clearing, leveling, etc. should be considered, but the timing of such new development should be delayed until the supply-demand relationship results in prices conducive to expansion of land at the extensive margin.

Slowing the rate of population growth is the remaining alternative approach. Where conflict exists or threatens to develop between the size of the population and the amount of food available, it is natural and desirable to work on devices to increase the supply of food. But it is logically fallacious and empirically shortsighted to ignore the alternative of population control.

There is a point of view extant that any and all increases to the numbers of the human race are by definition good, and that somehow it is the will of divine power that mankind should propagate increasingly. This point of view is in contrast to and conflict with the observed behavior of the human race. While the passion between the sexes observed by Malthus may be constant, the reproduction of the species is not constant. The response of fertility rates to changes in level of
prosperity and material well-being in civilized countries may not have
been fully quantified as yet, but the existence of some response is both
logically and empirically well founded. Logically, when an addition to
the family must result in a lower level of living for the existing
family, the prospective parents must "think twice" about the wisdom of
such increase in family size. While the relationship between babies
and new cars or new houses or new clothes may appear to be complementary
at present, certainly competition exists at some strata of society
between babies and an acceptable level of diet, of housing or of
personal attire. Empirically, the birth rate in America dropped to a
low level during the depression of the 1930's, and increased subse­
quently with the return of prosperity. When shortage of food supplies
becomes a factor in the life of a family, or when the material comforts
of life related to a satisfactory man-land ratio diminish, repercussions
in the form of reduced birth rate will be observed, and the size of the
population will increase less rapidly or become stable.

Ultimately, controls on population must be exercised. Some limit
exists to the extent and productivity of all resources upon which human
life depends; when that limit is reached, population must also reach
its limit. In the short run, the first listed factors may be utilized
to reduce or postpone the conflict between asymptotic resource produc­
tivity and geometric population increase. But eventually population
must also find an asymptote. Human population is subject to-planning
and intelligent control no less than the other factors in the equation,
and adjustment must be made on both sides if the consumers of land
resources and the supply of land resources are to be brought into balance.
The level at which balance is achieved is subject to human control. At the option of society, the equilibrium may be achieved at a bare subsistence level, or at a level approximating the ideal rates of land use or the ideal man-land ratio. The indications in this study are that stabilization of the population at a level not far from that projected for 1975 would achieve a desirable man-land ratio but that with anticipated achievements of technology increases in population much beyond 13.5 million for Ohio and 235 million for the nation must result in a lower level of living.

Several approaches to reconciliation of conflict between growth of population and demand for land resources have been discussed. Which of these should be utilized, and in what priority? Examination of the goals or objectives of society is necessary in order to answer this question.

**What Are the Goals of Society?**

Evaluation of any action or decision must be related to the objectives or goals toward attainment of which the action or decision is oriented. The action of society in producing increases in the population or the decision of society in allocating its land according to a certain pattern must be evaluated relative to the goals of society.

What are society's goals? The actions of society are inconsistent or incompatible with certain possible goals which can thus be ruled out; the residue may be imputed as goals. This process becomes more and more precise as choices are made, but to aid in planning to achieve the goals it is necessary to know ex ante what the goals are.
Important components of overall goals are attitudes with respect to size of population and standard of living, and the planning horizon. For example, a possible goal would be the maximum population at a subsistence level. This has been characterized as "humanity by the ton." Another possible goal is the highest obtainable level of living for a given population, disregarding the effect on subsequent generations. Still another extreme goal is conservation of all natural resources so that they will remain perpetually undiminished in substance, quality, and potential. Examples of support of each of these extreme positions can be detected in both individual and collective action and argument. Yet, a compromise is a more likely goal for society as a whole.

In which direction should we go? Toward achievement of what objectives should the allocation of land resources be planned? The man-land ratio, the specific use of land of varying characteristics, and the intensity of use within major categories, all are dependent upon the goals toward which society is oriented.

Clearly, a need for research along this line is indicated. Planning, no matter how carefully or thoroughly done, will achieve its objectives only by accident unless those objectives are known in advance.

Recommendations and Additional Research Needs

In addition to the need for more precise specification of the goals and objectives of society, reduction or postponement of the population, resource conflict calls for more research in land economics and the production sciences. All of the previously listed approaches
need to be further explored and their potentialities made explicit.

While technological development and innovation is far ahead of adoption of these devices and techniques by the farmer, the vastly increased need for advances in production after 1975 calls for the accumulation of a backlog of technology which can be called upon as needed. New horizons in food production, whether by development of food factories or by harnessing solar and nuclear power to agricultural operations, should be explored because of the boost which such changes might make. A breakthrough from the asymptote imposed by surface area, for example, would permit a whole new dimension for intensification of use of resources and would necessitate reexamination of the whole scheme of land allocation.

Importing of food into a deficit area of a state or a nation must be used as an adjunct to increasing regional specialization. Research in production sciences and in farm management should go beyond ex post studies of comparative advantage; research should pave the way for more efficiencies in production via this approach.

Research on diets should continue. Eating is a highly institutionalized activity. The effects of reduced physical activity on the amount and makeup of food needs, and the development of various types of protective and nutritional additives deserve research and study, not only because of their possible salutory effect, but because of secondary effects on the need for land. The popular acceptance of pre-packaged meals suggests that some of the traditional values of meat or other items in the diet may be replaced by convenience factors of other
foods, giving an avenue whereby cheaper foods might be made popularly acceptable.

Reallocation of land is a fertile field for both research and program development. A method needs to be developed for appraising the contribution to society's welfare of a given tract of land in alternative prospective uses. Utilization of such a method in decision-making should be promoted. Techniques and devices need to be developed or sharpened for assuring the allocation of land to uses which maximize achievement of society's long-time goals. Education, social pressure, zoning, taxation, government purchase of development rights, and outright social ownership are alternative methods whereby land use can be influenced. The relative efficiency of these methods and their secondary and side effects need to be better understood. Whichever of these or other methods are best for the purpose should be adopted and utilized. The nature and extent of land use is not fully known; the scarcity of statistics needed for this study and the necessity of using non-comparable data emphasize the desirability of more complete information on land use. More complete inventory and thorough study of the qualitative aspects of land is desirable, including soils and their use, their adaptability for present and other possible uses, their extent and location, and other factors.

Finally, more population research is needed. Studies should be conducted of the response in birth rate of different segments of society to various levels of income and material welfare, various degrees of uncertainty or risk and other factors. The results of this research should then be combined with the results of land economics research to
determine what incentives or penalties need to be posed for society or for sectors of society to bring about the adjustment of the man-land ratio to the level at which the maximization of society's goals is achieved.

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In summary, we are at a crossroads with respect to land use. The kind of a society we develop depends largely on how we utilize our land resources. The situation at the moment presents a paradox. We are confronted with an excess of agricultural products, and land is in surplus supply. Yet, there are strong indications that critical shortages of land will occur before the end of the present century. With a growing population, an increasing demand for the products and services of the land, and an increasing degree of fixity in the allocation of land among various uses, we must choose the pattern of land use which will emerge over the years. Public apathy or indecision in the face of private action and individual initiative constitutes public decision-making by default, and leads to many problems. Planning and study in advance can minimize or avoid many of these problems. Awareness of the problems and of the effects of the alternatives is essential to sound, constructive and forward-looking action with respect to land use in Ohio.
APPENDIX
APPENDIX A

LAND CAPABILITY CLASSES

Classes I, II, and III include the land that is suited for regular cultivation, and Class IV the land that can be safely cultivated only occasionally, that is, in a limited way. Classes V, VI, and VII include the land that is not suited for cultivation but is suited for grazing or forestry. Class VIII is reserved for the land that is not suited for cultivation, grazing, or forestry.

Class I is very good land from all points of view. It is nearly level and does not wash readily. The soil is deep and easy to work. It holds water well and is at least fairly well supplied with plant nutrients. Such land is scarce in many localities. It is not present at all on some farms... It should be managed so that a good supply of plant nutrients and good physical condition are maintained.

The other classes are farmed with greater difficulty or greater risk than the Class I land.

Class II is good land from every standpoint, but certain physical conditions make it not quite so good as Class I land. The slope may be just steep enough to make water run off at a speed which will carry away soil. Some Class II land is naturally wet and requires drainage. Some has not quite as good water-holding capacity as Class I land. Each of these deficiencies either limits the use of the land to some extent or requires some special attention year after year. Even a single farm can have two or more variations of Class II land...

Since Class II land has some moderate, natural use limitation, some special treatment is called for, such as easily applied conservation practices like contouring, protective cover crops, simple water management, crop rotations, and the use of fertilizers.

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1 This section is comprised of excerpts from J. G. Steele, "The Measure of Our Land" (Washington: Soil Conservation Service, 1951), pp. 5, 6, 12.
Class III is moderately good land for cultivation. It is more limited in use than Class II land by reason of one or more natural features. It can be used regularly for crops but, because of these natural restrictions, intensive treatment of some kind is called for. Several variations occur in Class III, as they do in Class II. Some Class III land is moderately sloping and must have intensive care to control erosion if used for crops in a regular rotation. Another variation of Class III land calls for water management because of poor drainage.

Class IV land is good enough for occasional cultivation under careful management, but it is not suited for regular production of cultivated crops. A large part of it is too steep for regular cultivation primarily because of the danger of erosion. Generally speaking, it can be cultivated safely perhaps 1 year in 6; in the other years its best use is for pasture or hay.

Class IV land, then, is only fairly good for crops other than grass. As a rule it is good grazing land and where rainfall is adequate it is good forest land.

Class V land is nearly level and not subject to erosion. Because of wetness, climate, or some permanent obstruction like rock outcrops, it is not suited for cultivation. The soil is deep, however, and the land has few limitations of any kind for grazing or for forestry use. Good management is of course needed for satisfactory production with either grass or trees.

Class VI land is not suitable for any cultivation, and it is limited somewhat for grazing or forestry by such features as shallow soil or steep slopes. Wherever the rainfall is adequate for crop production, the limitations of Class VI land are most likely to be steep slope, shallow soil, or excessive wetness that cannot be corrected by drainage to permit use for crops. In arid and semiarid regions lack of moisture is the principal reason for putting land in Class VI. This is good land for forestry or for grazing, although not so good as parts of the cultivable land classes.
APPENDIX A (continued)

Class VII is not only unsuited to cultivation but has severe limitations for use for grazing or for forestry. It requires extreme care to prevent erosion. In rough timbered areas its use for either grazing or lumbering requires special care.

Class VIII land is suited only for wildlife, recreational, or watershed purposes. Usually it is extremely arid, rough, steep, stony, sandy, wet, or severely eroded. Rocky foothills, rough mountain land, bare rock outcrops, coastal sand dunes, much marsh and swamp land, and very arid land not suited for any grazing for examples of Class VIII land.
APPENDIX B

BASIS OF POPULATION PROJECTIONS

The population projection for 1960-1970 presented in Table 20 is based on these assumptions:

Summary of assumptions.—In all, four series of State population projections were prepared, each based on a different combination of assumptions regarding future fertility, migration, and mortality. The particular assumptions used for each of the components of population change, for each series, are as follows:

Series 1:

a. Migration.—A combination of the 1950-55 and the 1940-55 levels is assumed. For the first part of the projection period (1955-60), 1950-55 levels are assumed to prevail; then, those levels are assumed to change linearly so as to equal the 1940-55 levels by 1970-75.

b. Fertility.—1954-55 rates (national Series AA rates in Series P-25, No. 123) prevail for the 1955-60 period; then these rates decline linearly to 1950-53 levels (national Series A rates) by 1970-75. State rates were based on national rates.

c. Mortality.—Projections were tied in with unpublished United States mortality rates furnished by the Social Security Administration.

Series 2:

a. Migration.—1940-55 levels of migration remain constant throughout the projection period.

b. Fertility.—1950-53 level (national Series A rates) remains constant to 1970. State rates were tied in with national rates.

c. Mortality.—State mortality was tied in with the general level of mortality in the national population projections in Series P-25, No. 123. The decreases in mortality observed during the 1940's will continue until 1960, after which the mortality rates will remain constant at 1955-60 levels.
APPENDIX B (continued)

Series 3:

a. Migration.--1930-55 level is assumed to apply throughout the projection period.

b. Fertility.--National Series A remains constant to 1970. State fertility rates were based on national rates.

c. Mortality.--Same as for Series 2.

Series 4: This series is the same as Series 3 except that State fertility was tied in with national Series C fertility (1950-53 rates decline from 1953 to about the 1940-42 levels by 1975). 1

The population projection for 1960-1980 (Table 21) is based upon these assumptions: 2

Mortality: One series of age-sex specific mortality rates was used for all four series of population projections. These rates implied some improvement in mortality as compared to current levels.

Net immigration: One series of allowances for future net immigration was used. As arbitrary allowance of 300,000 per year was used, roughly equal to the average annual net number arriving during the period 1951 to 1956.


Fertility rate: The current fertility level, represented by the 1955-57 average, is used as the base point for all fertility projections.

Series I: Fertility 10 percent above 1955-57 level throughout projection period.

Series II: Fertility at 1955-57 level throughout projection period.

Series III: Fertility declines from 1955-57 level to 1949-51 level by 1965-70, then remains constant to 1975-80.

Series IV: Fertility declines from 1955-57 level to 1942-44 level by 1965-70, then remains constant to 1975-80.
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In 1941-43 I was employed in private industry, and in 1943-46 I served in the Army Air Force. From 1949 to 1955 I was engaged in farming and for about 3 and one-half years of this time was also employed as manager of a grain elevator and feed mill.

I returned to Ohio State for graduate study in Agricultural Economics in 1955, and received the degree Master of Science in December, 1956. I was employed by the Ohio Agricultural Experiment Station as a research assistant during 1956 and as an assistant instructor beginning in January, 1957. I was appointed Instructor jointly by that institution and the Ohio State University in October, 1959. My duties consisted of research and teaching in the fields of farm management and land economics. While thus employed I completed the requirements for the degree Doctor of Philosophy.